ME- 1172

FORM 32429-1

c.2

OPERATION AND MAINTENANCE INSTRUCTIONS

CATERPILLAR®

D353 ENGINE

SERIAL NUMBERS

46B1-UP

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Warranty

Caterpillar Tractor Co. warrants products sold by it for six (6) months after date of delivery to the initial user, subject to the succeeding provisions hereof. This warranty is limited to the repair or replacement, as Caterpillar Tractor Co. may elect, at one of its factories designated by it, of such parts as shall appear to it, upon inspection, to have been defective in material or workmanship, but does not include any installation or transportation costs. No warranty is made with respect to items made by others (except items made by direct or indirect subsidiaries of Caterpillar Tractor Co.) when such items are warranted by their respective makers or when they are supplied by Caterpillar Tractor Co. on special order. No other warranty of any kind is made or authorized by Caterpillar Tractor Co., and no recommendation of items made by others shall imply or constitute any warranty with respect to such items.

T54255

Foreword

Caterpillar products are a result of advanced engineering, skilled manufacturing, and the finest materials metallurgical science can select. Thousands of satisfying, economical working hours are built into each machine.

Whether or not the owner derives the maximum service from his machine depends largely on the care exercised in its operation and maintenance. This book is written to give the operator essential information regarding the day-to-day operation, lubrication and adjustment of the machine. Careful adherence to these instructions will result in assured economy.

More and more Caterpillar owners are depending upon their dealer for service other than the care and adjustments described in this book. This practice is recommended because Caterpillar dealers have stocks of genuine Caterpillar parts and are equipped with tools designed and built by Caterpillar. Their servicemen are factory-trained and are kept closely informed by the factory regarding advanced methods of servicing Caterpillar products — thus, in all ways they are equipped to render the best of service.

T20841

Avoid Accidents

Most accidents, whether they occur in the air, in industry, on the farm, at home, on the highways, or at sea, are caused by someone's failure to follow simple and fundamental safety rules or precautions. For this reason most accidents can be prevented by recognizing the real cause and doing something about it before the accident occurs.

Regardless of the care used in the design and construction of any type of equipment, there are many conditions that cannot be completely safeguarded against without interfering with reasonable accessibility and efficient operation.

A careful operator is the best insurance against an accident.

The complete observance of one simple rule would prevent many thousands of serious injuries each year. That rule is: "Never attempt to clean, oil or adjust a machine while it is in motion."

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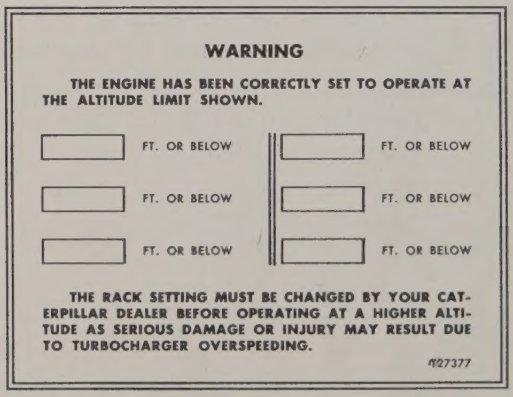
Turbocharger Operation


WARNING
THE ENGINE HAS BEEN CORRECTLY SET TO OPERATE AT THE ALTITUDE LIMIT SHOWN.
FT. OR BELOW
FT. OR BELOW
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FT. OR BELOW
THE RACK SETTING MUST BE CHANGED BY YOUR CATERPILLAR DEALER BEFORE OPERATING AT A HIGHER ALTITUDE AS SERIOUS DAMAGE OR INJURY MAY RESULT DUE TO TURBOCHARGER OVERSPEEDING.
127377

WARNING PLATE LOCATED ON INSTRUMENT PANEL

See page 39 for additional information about safe altitude operation.

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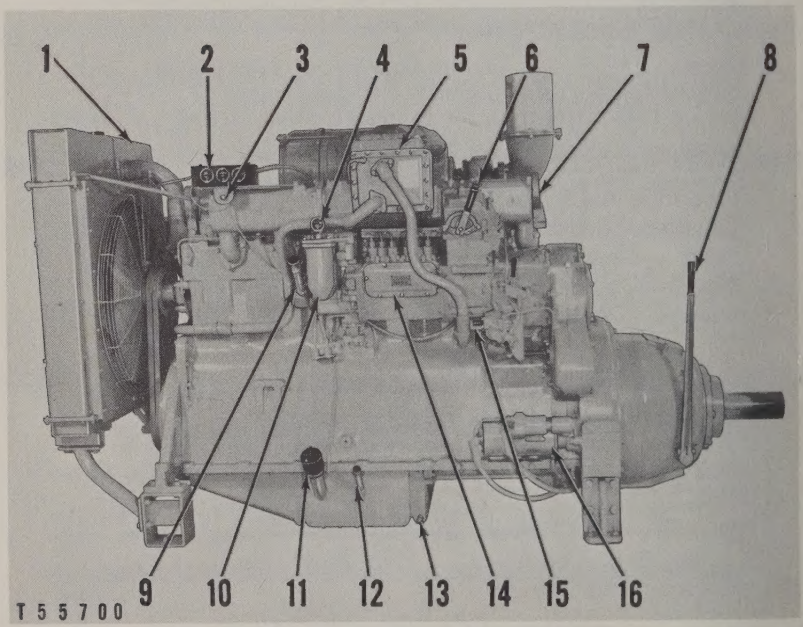
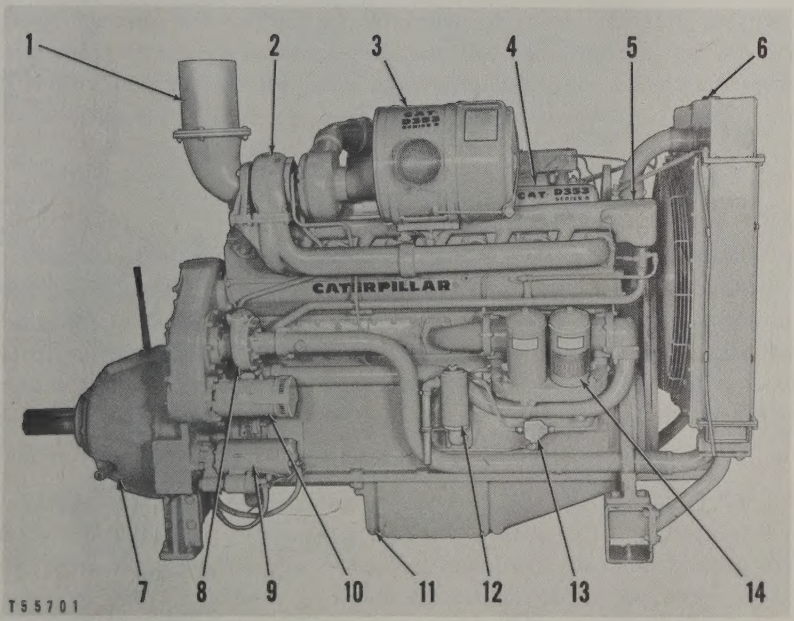


D353 ENGINE – WITH DUAL DIRECT ELECTRIC STARTING SYSTEM – LEFT VIEW

1–Radiator. 2–Diesel engine gauge panel. 3–Diesel engine electric starter switch. 4–Fuel pressure gauge. 5–Diesel engine aftercooler. 6–Governor control lever. 7–Lifting eye. 8–Enclosed clutch control lever. 9–Fuel priming pump. 10–Fuel filter housing. 11–Diesel engine crankcase lubricating oil filler cap. 12–Diesel engine crankcase lubrication oil level gauge. 13–Diesel engine crankcase drain plug. 14–Fuel filter housing. 15–Service meter. 16–Diesel engine electric starter for dual electric starting system.



D353 ENGINE - WITH DIRECT ELECTRIC STARTING SYSTEM - RIGHT VIEW

1–Diesel engine exhaust. 2–Turbocharger. 3–Dry-type air cleaner. 4–Diesel engine valve cover. 5–Water temperature regulator housing. 6–Coolant filler cap. 7–Flywheel clutch. 8–Diesel engine water pump. 9–Diesel engine electric starter. 10–Charging generator. 11–Diesel engine crankcase drain. 12–Diesel engine crankcase breather. 13–Turbocharger lubrication valve. 14–Diesel engine crankcase lubricating oil filter.

Installation Instructions

There are a number of factors that warrant careful consideration when installing an engine. Careful thought and planning on installation details can pay dividends in increased engine life and successful operation. Attention should be given to installation details that will make operation and maintenance easy, such as ample clearance around walls and surrounding machinery, accessibility for adjustment and maintenance, and proper provision for draining crankcase oil. The following comments will touch briefly on some of the more important factors, but for more specific recommendations, it is suggested that your Caterpillar dealer be consulted.

COOLING

Probably the most important consideration is that of making sure the engine will cool properly. Various types of cooling may be used successfully, the choice being governed by the type of engine application and local conditions. Cooling, however, is a complete subject within itself and is not covered in this book. Contact your Caterpillar dealer to obtain complete installation details. Following are certain fundamentals which can be mentioned.

In the initial planning of the installation, it is assumed that the most satisfactory cooling system was selected. If it is to be a permanent installation, a heat exchanger or cooling tower was probably chosen. With any type of installation a water cooled oil cooler is recommended. Normally, a permanent installation in a building would be cooled by means other than a radiator. If it is a portable unit, a radiator system may be used.

On heat exchanger and cooling tower installations, it is important to be sure that there is a sufficient flow of raw water at low enough temperatures to properly cool the engine. The piping should be carefully checked to be sure there are no air pockets that will restrict the flow of water and, if necessary, vents should be installed. It should be kept in mind, however, that very few vents will be needed if the piping is properly installed. Where necessary, flexible connections should be used to keep engine vibrations from being transmitted to the cooling water piping.

On radiator-cooled installations, the engine should always be placed so that the flow of air through the radiator is in the same direction as the prevailing wind. Strong cross winds materially reduce the cooling

capacity by cutting down the amount of air the fan can force through the radiator. On installations where the engine powers a machine that stirs up quantities of dust, such as rock crushers, it is advisable to locate the engine so that air passing through the radiator will be as free of dust as possible. Any accumulation of dust, dirt or lime on the radiator reduces cooling capacity.

Two or more radiator-cooled engines operated together should be so arranged that the discharged hot air from one engine does not pass through the radiator of the other. Each engine should be able to pass unheated air through its radiator.

CAUTION

Various packaging materials must be removed before operating the engine. Inspect the engine for shipping straps, brackets, bolts, skids and coverings before operation of the engine.

The radiator braces for this engine are not for shipping purposes and should remain on the engine after installation.

AIR SUPPLY

It is advisable to use a special precleaner or air inlet pipe extension on engines operating in extremely dusty conditions to keep the air precleaner up out of the dust and to prevent dust and lint entering the air cleaner.

EXHAUST LINES

Flexible connections should be used to prevent transmission of engine vibrations to exhaust piping. Flexible metal tubing is generally recommended for the exhaust connections at the engine. The weight of the exhaust lines must be supported so that no weight is imposed on the turbocharger. The exhaust outlet should be protected from the weather so that rain and snow cannot enter the line and get into the engine. The exhaust lines should be as short as possible. Long exhaust lines or lines with several bends should be of increased diameter so as not to create excessive back pressure. The back pressure should never exceed 15 inches of water on a new installation when measured with a manometer at the exhaust connection of the engine. Exhaust from the starting engine should be carried in a separate line and not connected into the diesel exhaust line.

BASE

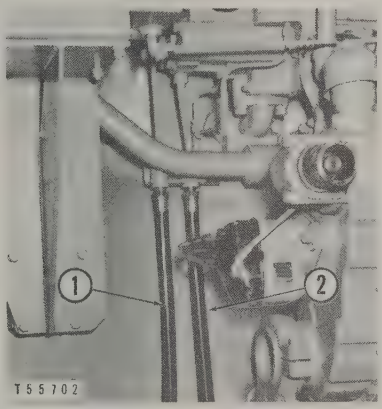
A chart is available that gives the necessary dimensions for making an engine installation. A concrete base may be constructed which will be satisfactory for all average conditions. Where the soil is sandy or extremely wet, the concrete base should be proportionately increased in

size both in length and width, to secure a firm and solid foundation. Reinforcing bars should be used to strengthen the walls especially at the corners.

Provisions should be made for draining the crankcase, either by providing a small pit for a container near the drain plug, or by extending the pipe and installing a shut-off valve close to the engine.

FUEL LINES

Flexible fuel lines **(1)** and **(2)** are recommended on all permanent installations. On power units where the fuel tank is not installed at the factory, connect a fuel line from the diesel fuel tank to the fuel transfer



FLEXIBLE FUEL LINES

1–Fuel return line. 2–Fuel supply line.

pump flexible line. The transfer pump will lift fuel the height of 12 feet through no more than 50 feet of pipe. Also, remove the cork and connect a return line from the fuel filter adapter to the diesel fuel tank. It is essential that there be no air leaks in the suction system. Even a small leak will destroy the suction lift of the transfer pump.

CAUTION

Do not connect a line between the adapter and the fuel inlet to the fuel transfer pump as this may cause the system to become air bound. If a pipe plug is installed in place of the cork or if the return tube is too small, fuel pressure will burst the housing.

ENGINE AND CLUTCH ALIGNMENT

After the engine has been secured to the foundation, if it is equipped with an extended clutch shaft and pillow blocks the engine should be aligned with the clutch shaft by removing or adding shims under the engine rear support assembly and pillow block. Additional shims for this purpose are furnished with the clutch and pillow block group.

The standard engine, with a flywheel clutch, has the flywheel clutch control lever located on the left side of the unit. If the installation of the unit makes it desirable, this control may be shifted to the right side.

CRANKCASE BREATHER FUMES DISPOSAL

The crankcase breather fumes disposal tube should be directed or extended to a location that will prevent an oily film from being deposited in the engine room. If oily fumes were allowed to be drawn into the engine dry type air cleaner, frequent air cleaner filter element servicing will result. A 1 inch (2.54 cm.) tube not to exceed 25 feet (7.6 meters) in length connected to the crankcase breather fumes disposal tube and piped to the atmosphere is recommended. Greater lengths will cause excessive crankcase back pressure. Also in order to keep crankcase pressure low, the number of bends should be kept to a minimum. Loops and low spots in the tube should be avoided or improper crankcase breathing will result from trapped condensate in the loops and low spots.

GENERATOR REGULATOR INSTALLATION

When the unit is equipped with a 32-volt charging generator it is advisable to mount the generator regulator at some other location than on the engine. This will reduce to a minimum damage or irregular operation of the regulator which might be caused by vibration or oil and water from the engine.

CORRECT AIR CLEANING IS NECESSARY

Caterpillar air cleaners are designed to remove all harmful elements from the air entering the engine. Dusty atmospheric conditions will cause frequent servicing and short element life. Precleaners are available to provide reasonable service periods and element life. Air inlet extension can be utilized to provide cleaner and cooler air to the air cleaner. Your Caterpillar dealer has additional information.

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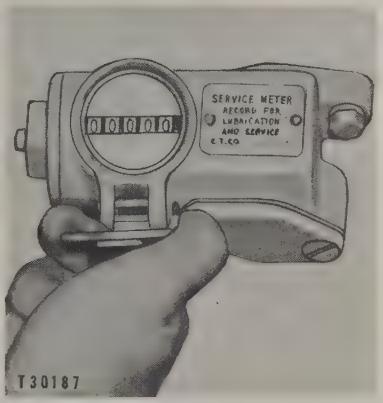
Lubrication Instructions

SERVICE METER

The Service Meter is located on the left side of the engine near the bottom of the governor and fuel injection pump drive housing. It is geared to the engine, and when the crankshaft turns as many revolutions as are made in an hour at normal operating speed, the dial advances one number. There are some applications that will result in either a lower or higher than normal average engine speed. Under these conditions, the advance in the Service Meter reading will differ from the number of clock hours of operation.

The purpose of the Service Meter is to indicate when to perform the recommended maintenance and lubrication operations. The established intervals in the lubrication chart and maintenance instructions are given in service hours, so daily readings will tell when to service the engine. Rely on the Service Meter and not on the clock to measure service intervals.

COVER ON SERVICE METER RAISED TO OBSERVE DIAL READINGS



GENERAL LUBRICATING INFORMATION

Careful attention to the following information on lubricants and their proper selection will add much to performance, economy and long life of your engine. The lubrication chart specifies the lubricants to be used, the points to be serviced and the hourly intervals of servicing according to Service Meter hours.

Lubricate all miscellaneous points, not equipped with fittings, with crankcase lubricating oil every 50 service hours.

It is extremely important in handling the oil to keep it clean. Every precaution should be taken to use only clean filler cans and funnels and to be sure that all dirt is removed from the filler cap before it is taken off for filling. The operator should take every precaution to prevent dirt from getting into any system to extend the life of the engine.

DESCRIPTION OF LUBRICANTS

The lubricants recommended for use in this engine can be identified by the sub-headings preceding their descriptions that follow: The proper selection of one of these types of crankcase lubricating oils, and SAE grade of oils can be made from the information in the topic, TYPE OF LUBRICANTS AND SAE GRADES TO USE.

Crankcase Lubricating Oils

Superior Lubricants (Series 3): These are additive-type oils that have been identified as meeting a rigid, high quality standard and certified for use in all Caterpillar Diesel Engines. See your Caterpillar dealer for brand names of products conforming to this specification.

MIL-L-2104A Specification Oils: These oils are additive-type but are milder than Superior Lubricants (Series 3) Oils. They can be used as specified for various compartments satisfactorily. Your oil supplier is familiar with those oils meeting the MIL-L-2104A Specification.

Lubricating Grease

Ball and Roller Bearing Lubricant: This lubricant is a mixture of mineral oil and metallic soaps. Use No. 2 grade for most temperatures. For extremely low temperatures use No. 0 or No. 1 grade.

This grease can be applied to all bearing points — plain bearings, ball bearings and roller bearings — where equipped with hydraulic pressure fittings or when bearings are hand packed.

Use only a high grade short fiber grease. This grease must be satisfactory in anti-friction bearings at speeds up to 3000 RPM at a maximum temperature of 300° F. It is a grease with sufficient adhesive qualities to cling to the bearings in all extremes of high and low operating temperatures.

Type of Lubricants and SAE Grades to Use

The grade of oil is classified in terms of viscosity (fluidity or flow ability) and is identified with numbers called SAE numbers. The lower SAE numbers are more fluid and flow more readily than do those with the higher numbers within the same series.

SAE 10W oil should be fluid enough for easy cranking at starting atmospheric temperatures down to at least −10° F. When starting in temperatures below −10° F., the diesel engine crankcase lubricating oil should be warmed to provide fluidity in cold weather. **Do not dilute** the diesel engine crankcase lubricating oil.

The oil specification chart will aid in the proper oil grade selection for the various compartments. The proper SAE grade of oil to select is determined by the atmospheric temperature at which the machine **is started.** However, during **operation** SAE 10W oil can be used successfully in the diesel engine crankcase when atmospheric temperatures are as high as 70° F.

OIL SPECIFICATION CHART

Compartment	SAE GRADE OF OIL TO USE AT STARTING ATMOSPHERIC TEMPERATURE			
	Above +32°F.	+32°F. to +10°F.	+10°F. to −10°F.	−10°F. and Lower
Diesel Engine Crankcase	Superior Lubricants (Series 3)			
	SAE 30*	SAE 10W*	SAE 10W*	Heat SAE 10W
†Starting Engine Crankcase	Superior Lubricants (Series 3) or MIL-L-2104A‡			
	SAE 30*	SAE 10W	SAE 10W	**Dilute SAE 10W

*In seasons or locations where starting atmospheric temperatures are below 32° F., SAE 10W oil should be used to insure free circulation, even though daytime operating temperatures may rise as high as 70° F.

**In lower temperatures it may be necessary to dilute oil with kerosene so it will be fluid enough to insure free circulation. This should be done before stopping, then operate the engine for a few minutes to mix kerosene and oil. Evaporation in the engine crankcase under steady operation may make it necessary to again add kerosene to maintain proper fluidity.

†Disregard the starting engine SAE Grade of oil recommendations if the starting engine lubricating oil system is interconnected with the diesel engine lubricating oil system.

‡For oil bath air cleaners it is permissible to use clean undiluted reclaimed oil or the most inexpensive straight mineral oil. Be sure to change oil in the air cleaners regularly.

To determine if the oil in the compartments will flow in cold weather, remove the oil level gauge or dip a finger into the oil before starting and if the oil will flow off, the oil is fluid enough to circulate properly.

Diesel Engine Crankcase Lubricating Oil Change Periods

The crankcase lubricating oil change periods for these engines have been carefully established for the purpose of protecting the service life of the engine as economically as possible.

DIESEL ENGINE CRANKCASE LUBRICATING OIL CHANGE PERIODS*
Use Only Superior Lubricants (Series 3)

Fuel Sulphur Content	When Equipped With 40 quart System		When Equipped With 90 quart System	
	Change periods in Service Hours		Change period in Service Hours	
	Oil	Filter	Oil	Filter
0.4% or Less	250	250	500	500
0.4% to 1.0%**	125	125	250	250

*Regardless of time operated the crankcase oil should be changed at least once every six months.

**Reduce change periods one half when sulphur content is greater than 1.0%.

Change the oil and filter elements after the first 10 service hours of operation of a reconditioned engine.

LUBRICATION CHART
CATERPILLAR
DIESEL D353 ENGINE

The folded page is arranged for two purposes:

First, it is a complete outline of all information required to lubricate the engine.

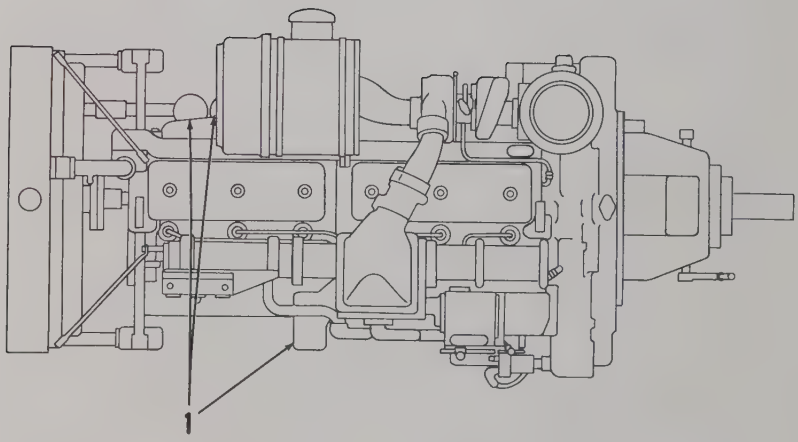
Second, the illustration and identification of points of lubrication can be used with the detailed illustration and information on the pages following the chart as a reference for lubrication and service information.

Key to Lubricants

CO Crankcase Lubricating Oil

Point and Identification	Lubricant	SERVICE HOURS 10	50	125	250	500	1000
** Diesel Engine Air Cleaner	CO	*X	X				
1 Diesel Engine Crankcase and Turbocharger Lubricating Oil System	CO	X		†X	†X	X	X

Location of Points of Lubrication



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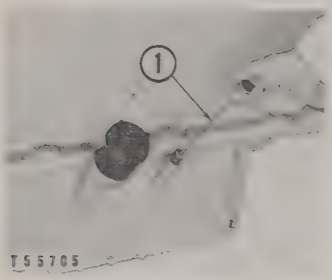
*Only when operating in extremely dusty conditions.

†See the diesel engine CRANKCASE LUBRICATING OIL CHANGE PERIOD CHART.

**Earlier model engines with oil bath air cleaners.

CO Crankcase Lubricating Oil



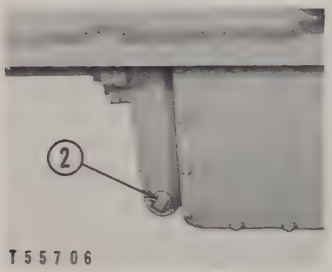
1

DIESEL ENGINE CRANKCASE LUBRICATING OIL SYSTEM

Use Superior Lubricants (Series 3) only

Check oil level with engine running every 10 service hours. Oil level should be between the "full" and "add oil" marks on gauge (1). The oil level maintained at the "full" mark is more desirable, however, any level above the "add oil" mark is permissible.

The oil level may be considerably higher than the "full" mark on the gauge if the full capacity of crankcase oil is checked after the engine has been stopped for several minutes. See the topic, "Crankcase Lubricating Oils." Also see Note A.

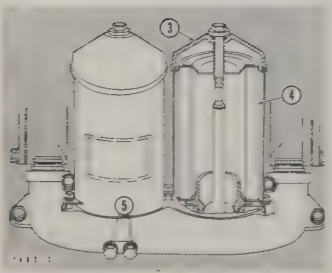


1

DIESEL ENGINE CRANKCASE LUBRICATING OIL SYSTEM

Drain the crankcase at (2) while the engine is hot. See the "Diesel Engine Crankcase Lubricating Oil Change Period Chart." See Note B.

When equipped with a gasoline starting engine having an interconnected lubricating oil system, also drain the starting engine crankcase. See the topic, "Starting Engine Crankcase".



1

DIESEL ENGINE CRANKCASE LUBRICATING OIL SYSTEM

Use Superior Lubricants (Series 3) Only

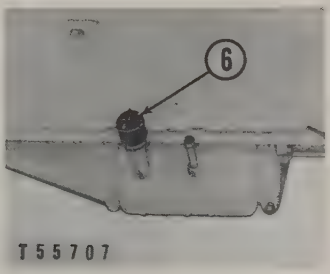
While oil is draining from the crankcase, remove the drain plugs (5) to drain the oil from the oil filter. Remove the cover (3) and the element (4) and install a new Caterpillar element. Install a new gasket if necessary, then install the cover and tighten the clamp screw. Clean and install the drain plugs.

Earlier engines are equipped with only one oil filter drain plug.

NOTE A: The diesel engine has a guard to protect the gauge from spray so the oil level should be checked when hot with the engine running at low idle speed. Always check the oil level with the engine in a level position.

NOTE B: Caterpillar Diesel Engines are built in a clean modern diesel engine factory. For this reason the initial crankcase oil change period for this engine should be at the usual crankcase oil change period. See the "Diesel Engine Crankcase Lubricating Oil Change Period Chart." For the type and SAE grade of oil to use, see the "Oil Specification Chart."

CO Crankcase Lubricating Oil



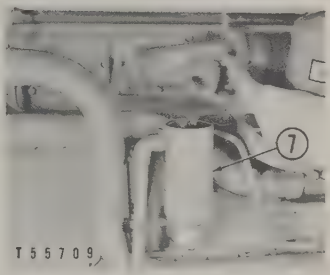
1

DIESEL ENGINE CRANKCASE LUBRICATING OIL SYSTEM

Use Superior Lubricants (Series 3) only

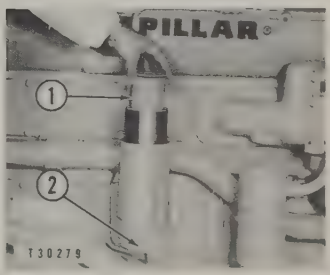
After draining crankcase, refill at (6) and start the diesel engine. Run the engine for two minutes, then add oil to bring level to "full" mark on the gauge while the engine is running. See the topic, "Type of Lubricants and SAE Grades to Use".

Disassemble breather (7) and wash elements each time crankcase oil is drained.



TURBOCHARGER OIL FILTER

On earlier engines equipped with a turbocharger oil filter, every 500 service hours drain the housing at (2) and remove the cover and screw as a unit. Lift out the element and replace it with a new Caterpillar element. Install the drain plug, fill the housing with the same grade of oil used in the diesel engine crankcase, and reinstall the housing cover.

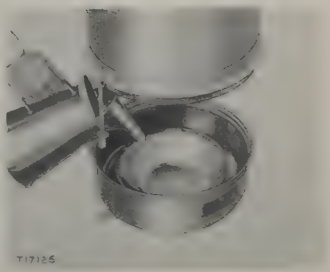


DIESEL ENGINE AIR CLEANER CUP

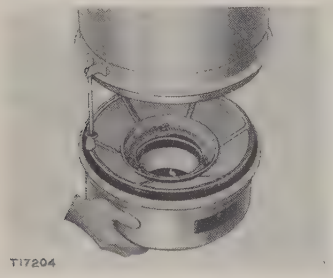
Engines Before 46B599 (With Oil Bath Type Air Cleaners)

Inspect the oil in the air cleaner cup every 10 to 50 service hours depending on dust conditions. Wash and fill both the inner and outer cups to the flat face of the inner cup either when the oil will not flow freely, the sediment in the cup is ½ inch deep, or every 50 service hours, whichever occurs first. See the topic, "Air Cleaners".

Refill the cup with the same SAE grade of oil as is used in the diesel engine crankcase and the same type of oil may also be used. However, it is permissible to use clean, undiluted reclaimed oil or the most inexpensive straight mineral oil. See the topic, "Crankcase Lubricating Oil."



CO Crankcase Lubricating Oil


T17204

DIESEL ENGINE AIR CLEANER TRAY ASSEMBLY

When the oil cup is removed for inspection, remove the air cleaner separable tray screens from the cup, inspect and wash them if dirty. Inspect the inside of the air cleaner inlet pipe and clean if necessary.

Clean the inside of the air cleaner inlet pipe every 50 service hours. See the topic, "Air Cleaners".

Engines effective with 46B599 are equipped with a dry-type air cleaner which does not require oil.

T47075

TURBOCHARGER BREATHER

(Earlier Engines)

At each crankcase oil change period, remove the element from the turbocharger breather and wash it in clean kerosene. Install the element.

Lubrication of Attachments

The following list of identifying letters, names of attachments requiring lubrication, and types of lubricant required will help in lubrication of attachments.

Identification of Points of Lubrication, Lubricant to Apply and Interval of Service

CO Crankcase Lubricating Oil **BR** Ball and Roller Bearing Lubricant

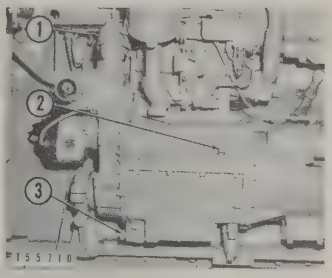
Point and Identification		Lubricant	SERVICE HOURS 10	50	125	250	500	1000
A	Starting Engine Crankcase	CO	X		†X	†X		
B	Starting Engine Air Cleaner	CO		X				
C	Starting Engine Transmission	CO				X		X
D	Enclosed Clutch Shift Collar Shaft	CO		X				
E	Enclosed Clutch Shift Collar and Shaft Bearings	BR	X	X				
F	Enclosed Clutch Pilot Bearing	BR			X			
G	Air Starting Motor Oiler	CO	X					
H	Air Starting Motor Gear Drive and Plain End							
I	Tachometer Drive	BR						X
J	Fan Bearings	BR				X		
K	Charging Generator	BR			X			
L	Electric Starting Motors	CO	See detailed information on page 18					
M	Woodward Governor	CO	X				X	

†See the diesel engine CRANKCASE LUBRICATING OIL CHANGE PERIOD CHART.

CO Crankcase Lubricating Oil

A

STARTING ENGINE CRANKCASE



Check the oil level every 10 service hours before starting the engine. Oil should be up to full mark on gauge (2).

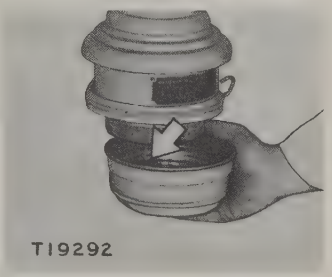
Every 125 to 250 service hours, depending on dust conditions, drain the crankcase at (3). When draining, the engine must be level so the oil in the starting engine clutch compartment will drain. Wash the crankcase breather at each oil change period. Refill the crankcase at (1). Fill slightly above the "full" mark on the gauge. Start and run the starting engine at least one minute to equalize the oil level in the crankcase and clutch compartment. Stop the engine and check the oil level. The oil level should be up to the "full" mark on the gauge.

If the starting engine has an oil system interconnected with the diesel engine lubricating oil system, the crankcase should be drained at each diesel engine oil change period. The starting engine crankcase, equipped with interconnected system, must be filled to the "full" mark on the gauge with the same type and SAE grade of oil used in the diesel engine crankcase before starting the starting engine. See the topic "Type of Lubricants and SAE Grades to Use."

B

STARTING ENGINE AIR CLEANER

Engines Before 46B509



Inspect the oil in the air cleaner cup every 50 service hours. Wash and refill cup to oil level bead when oil will not flow freely or if the sediment in the cup is 1/4 inch deep. See the topic, "Air cleaners".

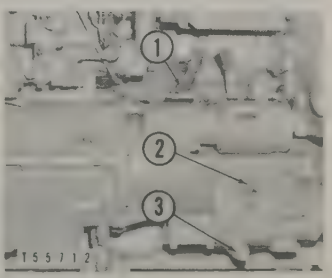
Refill the cup with the same SAE grade of oil as is used in the diesel engine crankcase and the same type of oil may also be used. However, it is permissible to use clean, undiluted reclaimed oil or the most inexpensive straight mineral oil.

See the topic, "Crankcase Lubricating Oil."

Engines effective with 46B509 are equipped with a dry-type air cleaner which requires no oil.

C

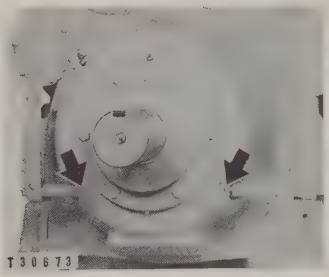
STARTING ENGINE TRANSMISSION



Every 250 service hours check oil level. Oil should be up to "full" mark on gauge (2). Remove, wash and oil the breather.

Every 1000 service hours drain at (3). Wash and refill at (1) to "full" mark on gauge. See the topic, "Washing Gear Compartments".

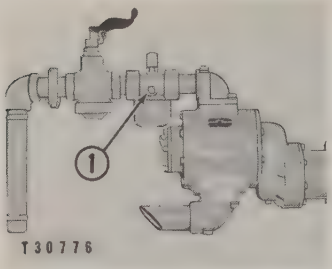
CO Crankcase Lubricating Oil



D

ENCLOSED CLUTCH SHIFT COLLAR SHAFT

Lubricate shift collar shaft bearings every 50 service hours.



G

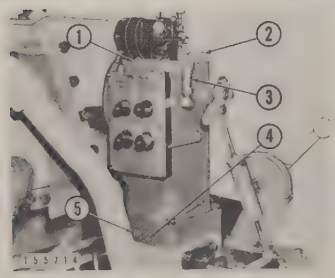
AIR STARTING MOTOR OILER

Every 10 hours check oil level in oiler by removing plug (1). Keep oiler filled at all times.

L

ELECTRIC STARTING MOTORS

Electric starting motors for the starting engine and the diesel engine are equipped with bearings of a type that make lubrication necessary only when the starter is disassembled for cleaning or servicing. Two or three drops of oil for each bearing is sufficient.



M

WOODWARD UG8 GOVERNOR

Check oil level every 10 service hours. Oil level should be visible in gauge and up to full mark (3). Replenish with STRAIGHT MINERAL lubricating oil at (2) to bring the oil level to full mark. Use the same viscosity oil as is recommended in the topic, "Crankcase Lubricating Oil," except in extremely hot weather use SAE 50 oil.

Every 500 service hours drain, wash and refill governor housing. To do this, remove drain plug (4) and needle valve plug (5). Unscrew the needle valve three turns and fill the governor housing with clean kerosene or diesel fuel. Run engine thirty seconds then drain and refill with STRAIGHT MINERAL lubricating oil. Start the engine then screw the needle valve in three turns and install the needle valve plug (5).

Every six months, regardless of service hours operated, remove top cover (1) from governor and governor from engine then drain by turning the governor upside down. Fill and flush the governor with clean kerosene or diesel fuel. The friction cover may fall out, if loose, but no other governor parts will be dislocated by turning the governor upside down. Reinstall the governor and fill with STRAIGHT MINERAL lubricating oil. Replace the friction cover and top cover.

BR Ball and Roller Bearing Lubricant

E

ENCLOSED CLUTCH SHIFT COLLAR AND SHAFT BEARINGS

Lubricate the shift collar through fitting (1) every 10 service hours. Lubricate the shaft bearing through fitting (2) every 50 service hours.

F

ENCLOSED CLUTCH PILOT BEARING

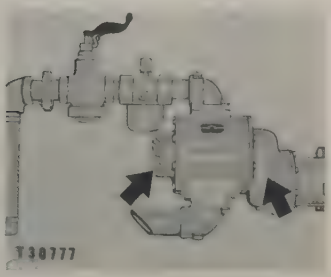
Lubricate the clutch pilot bearing every 125 service hours.

When the fitting cannot be lubricated as shown above, remove plate on the top right side of the flywheel housing and turn the flywheel until fitting appears. Lubricate sparingly every 125 service hours.

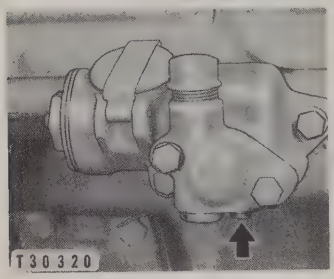
H

AIR STARTING MOTOR GEAR DRIVE AND PLAIN END

Air starting motor gear drive and plain end bearing compartments are packed at the time of assembly and require no periodic lubrication. If the motor is disassembled for any reason. No. 1 BALL AND ROLLER BEARING LUBRICANT should be used to fill the compartments.



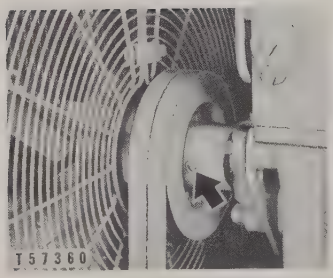
BR Ball and Roller Bearing Lubricant



I

TACHOMETER DRIVE

Remove pipe plug, insert 1/8 inch hydraulic fitting and lubricate sparingly every 1000 service hours.



J

FAN BEARING

Lubricate every 250 service hours.

K

CHARGING GENERATOR

If the generator is equipped with a front oiler tube lubricate the generator every 250 service hours with 2 or 3 drops of oil. Excessive oiling can cause damage to the armature.

Generators not equipped with oiler tubes have bearings packed with BALL AND ROLLER BEARING LUBRICANT making lubrication necessary only when the generator is disassembled for cleaning or servicing.

Operation Instructions

PREPARING THE ENGINE FOR USE

New Engine Initial Service: The first duty of anyone charged with the care and operation of an engine is to give it a detailed inspection, and to lubricate all parts as directed in the LUBRICATION INSTRUCTIONS section of this book.

Fill the diesel fuel tank, taking care no dirt, water, or other foreign substances are admitted with the fuel. Give particular attention to the details of fuel handling as outlined under the topic, CARE OF THE FUEL SUPPLY. If the diesel engine is equipped with a starting engine, fill the starting engine fuel tank with gasoline.

Fill the fresh water cooling system with clean soft water, or with the correct anti-freeze solution if temperatures below freezing are likely to be encountered. See the topic, COOLING SYSTEM.

New Engine Recheck: After the first 100 to 125 service hours of operation, tighten the diesel engine cylinder head stud nuts, inlet manifold stud nuts, exhaust manifold stud nuts and the turbocharger mounting bolts and nuts. If the diesel engine is equipped with a starting engine, tighten the starting engine cylinder head bolts and the carburetor elbow nuts.

When the diesel engine cylinder head nuts are tightened and the valve mechanism cover is removed, check the diesel engine valve clearance and adjust if necessary as described in the topic, DIESEL ENGINE VALVE CLEARANCE ADJUSTMENT.

New Operator's Responsibility: The operator who is given the responsibility of care and operation of an engine already in service, should first check it for necessary lubrication, fuel supply and coolant in the fresh water system.

Second, the engine should have any necessary adjustments made to obtain satisfactory performance.

STARTING THE ENGINE

There are three methods available for starting the diesel engine; gasoline starting engine, electric starting motor and air starting motor. The three methods are covered in these instructions. The following topic covers the starting information required, regardless of the starting method involved.

Before Starting: Check the diesel engine crankcase oil level to be sure it is considerably above the "add oil" mark on the gauge. Check the oil level in the starting engine crankcase to be sure it is to the "full" mark on the gauge. Check the oil level in the starting engine transmission to be sure it is to the "full" mark on the gauge.

When the engine is equipped with an oil pressure shut-off, or an oil pressure alarm switch, see one of the topics, SAFETY SHUT-OFF CON-

TROLS, or OIL PRESSURE ALARM SWITCH for further starting instructions.

Disengage or remove any load possible from the engine, then start the engine as described in one of the following topics, whichever applies, GASOLINE STARTING ENGINE, DIRECT ELECTRIC STARTING OR AIR STARTING.

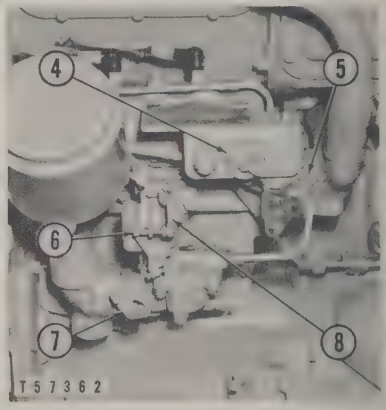
Gasoline Starting Engine

The gasoline starting engine may be used to start the diesel engine without the use of starting aids. However, starting aids may be used in lower temperatures to obtain quicker starts if desired. See the STARTING AID CHART.

Position Controls For Starting: Before attempting to start the starting engine, position the controls of both the diesel and starting engine:

CONTROLS POSITIONED FOR STARTING

1–Governor control lever in shut-off position. 2–Compression release lever in START position. 3–Starting engine clutch control lever in disengaged position.



STARTING ENGINE CONTROLS

4–Magneto switch. 5–Fuel valve control. 6–Throttle control lever. 7–Choke control. 8–Idling latch.

1. Check the crankcase oil level in the starting engine to make certain the oil is up to the "full" mark on the gauge.
2. Move the compression release lever **(2)** to the START position.
3. Move the governor control lever **(1)** to the shut-off position so the fuel injection pumps are closed.
4. See that the starting engine clutch is disengaged by moving the clutch control lever **(3)** toward the rear of the diesel engine.
5. Open the starting engine fuel valve by turning the fuel valve control **(5)** in the counterclockwise direction.
6. Turn the starting engine choke control **(7)** clockwise to the on position.

7. Move the idle latch **(8)** to hold the throttle control lever **(6)** in the idling position.
8. Turn ON the magneto switch **(4)**.

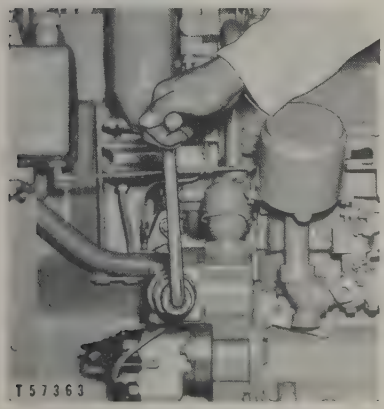
Starting the Starting Engine: The starting engine may be started manually or by means of the starting engine electric starter if so equipped.

Helpful suggestions for starting the starting engine in cold weather are in the topic, STARTING IN COLD WEATHER.

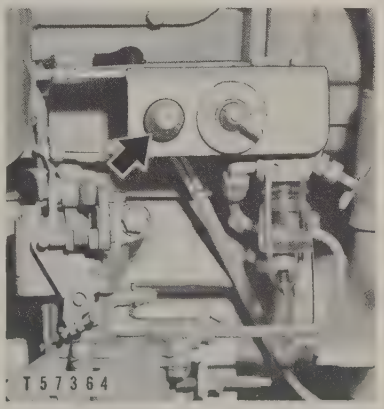
Manual Starting

1. Insert the crank into position and crank until the engine starts. **Pull the crank through a compression stroke. DO NOT attempt in any manner to spin or push the crank through a cranking arc.**
2. Move the choke control counterclockwise when the engine will run with the choke off. Temperature and altitude will vary the length of time it is necessary to have the choke on. Actual experience in starting will determine this interval.

   When the engine starts, keep the engine speed low until the crankcase lubricating oil has a chance to warm up and better lubricate the engine.



CORRECT POSITION FOR CRANKING STARTING ENGINE



STARTING ENGINE ELECTRIC STARTER SWITCH

Electric Starting

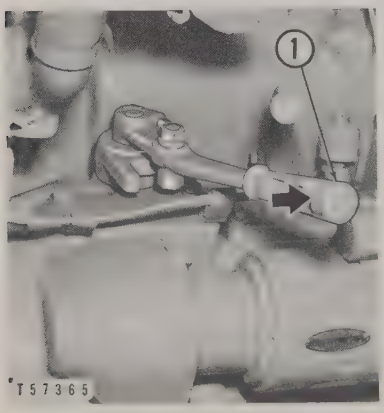
1. Press the electric starter switch to crank the engine. **Do not run the starter for more than thirty seconds at a time. Then, allow two minutes for cooling before using it again.** If the electric starter pinion disengages for any reason before the engine starts, release the starter switch and wait until the starting motor stops turning and the starting engine stops "rocking" before again pressing the starter switch.

2. Move the choke control counterclockwise when the engine will run with the choke off. Temperature and altitude will vary the length of time it is necessary to have the choke on. Actual experience in starting will determine this interval.

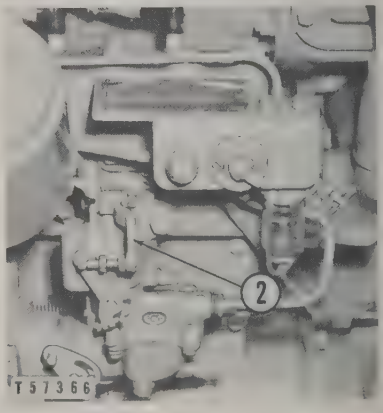
   When the engine starts, keep the engine speed low until the crankcase lubricating oil has a chance to warm up and better lubricate the engine.

Starting the Diesel Engine: When using the gasoline starting engine, the steps to start the diesel engine **should be carefully followed to prevent damage to the starter pinion or the flywheel ring gear.**

1. Move the idling latch **(2)** up to allow the starting engine to run at high idle speed.
2. Apply sufficient pressure to the starting engine clutch brake to **stop the starter pinion from rotating** by pushing the clutch and starter pinion control lever **(1)** all the way toward the rear of the diesel engine and hold it in the brake applied position for at least 5 seconds.
3. Engage the starter pinion with the flywheel ring gear and engage the clutch by **quickly** pulling the clutch and starter pinion control lever toward the front of the diesel engine until the clutch snaps over center.



APPLYING CLUTCH BRAKE
1–Clutch and starter pinion control lever.



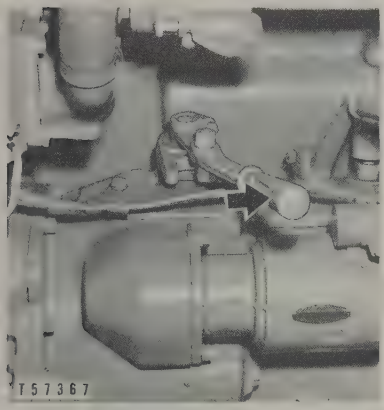
STARTING ENGINE THROTTLE CONTROL
2–Idling latch.

4. If the engine slows to the stalling point when the clutch is engaged, as it might in cold weather, disengage the clutch and let the engine pick up speed again. See the topic, STARTING IN COLD WEATHER.

During cold weather, or whenever the normal cranking speed cannot be reached with the transmission control lever in HIGH position, the LOW position of the starting engine transmission will be found quite beneficial.

To use the starting engine transmission for starting a cold engine proceed as follows:

1. Disengage the starting engine clutch.
2. Shift the starting engine transmission into LOW.
3. Engage the starting engine clutch and after the cranking effort required is reduced, move the compression release lever to the RUN position.

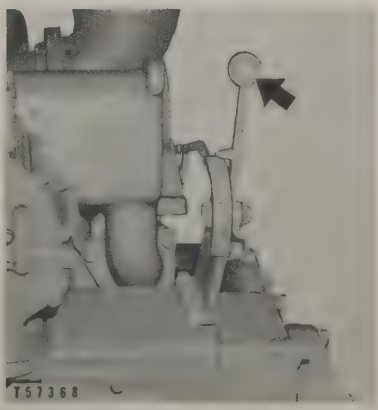


STARTING ENGINE TRANSMISSION CONTROL LEVER IN LOW SPEED POSITION

◆

4. Allow the starting engine to turn the diesel engine for several minutes as the heat of compression will assure easy starting.
5. Move the compression release lever to the START position, disengage the starting engine clutch, shift the starting engine transmission to HIGH.

If the engine is equipped with glow plug starting aid attachment for quicker starting in lower temperatures, press the glow plug switch at this point in the starting operation. See the topic, OPERATING STARTING AIDS.



COMPRESSION RELEASE LEVER IN RUN POSITION

◆

6. Engage the clutch and move the compression release lever to the RUN position when the starting engine is cranking the diesel engine at normal cranking speed.

The heat generated when the starting engine is cranking the diesel engine against compression, and the circulation of the starting engine exhaust through the tube in the diesel engine air inlet pipe warms the cylinders, pistons and combustion chambers to the starting temperatures. Actual experience will determine the length of time necessary to crank the diesel engine to warm it sufficiently to assure easy starting.

7. Move the governor control lever to approximately half engine speed position. When the diesel engine begins to run, the starting engine clutch and starter pinion automatically disengage.

After the diesel engine starts, reduce engine speed to low idle with no load. Do not apply any load to the engine or increase engine speed until normal oil pressure is indicated on the gauge. Avoid unnecessary accelerating of the engine before operating temperatures are obtained. When the gauge indicates normal oil pressure, the engine should be allowed to run for five minutes with the governor control lever at approximately half speed position before applying the load. During this period the engine gauges should be observed for proper readings as explained in the topic, GAUGES.

If the engine is equipped with ether starting aid attachment for quicker starting in lower temperatures, discharge ether into the manifold of the diesel engine at this point in the starting operations. See the topic, OPERATING STARTING AIDS.

GOVERNOR CONTROL LEVER IN APPROXIMATE HALF ENGINE SPEED POSITION FOR STARTING

If the diesel engine is thoroughly heated but does not start, see that everything is correctly set for starting. If smoke has been coming from the diesel engine exhaust pipe, fuel has been reaching the cylinders. If no smoke is evident when the governor control lever is in the half engine speed position, check the fuel supply. If the diesel fuel tank is empty,

or if the valve was closed, it will be necessary to prime the fuel system as outlined under the topic, PRIMING THE FUEL SYSTEM. In case there may be water or dirt in the fuel system, or if the fuel injection equipment is suspected, see the topic, FUEL INJECTION EQUIPMENT.

8. Move the idling latch to hold the starting engine throttle control lever in the idling position. Stop the starting engine by closing the fuel valve control, allowing the engine to burn all the fuel in the carburetor, then turn OFF the magneto switch.

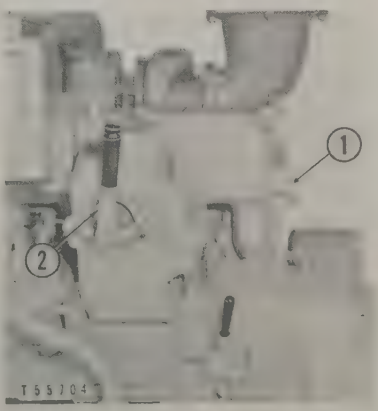
Direct Electric Starting

The diesel engine electric starter can be used successfully in atmospheric or engine room temperature of 60° F. (16° C.) or above **without** the use of a starting aid. **It is not advisable** to use the diesel engine electric starter in temperatures below 60° F. (16° C.) without the use of a starting aid. See the topic, OPERATING STARTING AIDS. Even when a starting aid is used in temperatures below 32° F. (0° C.), it is advisable to use crankcase lubricating oil of a lower viscosity in the engine crankcase to reduce the cranking effort required. See the topic, CRANKCASE LUBRICATING OIL.

The engine must be kept in the best mechanical condition possible, the batteries kept fully charged and all terminals kept clean and tight for satisfactory performance of the starting system in lower atmospheric or room temperatures. In extremely cold temperatures the use of an engine room heater or cooling system auxiliary heater will make starting easier.

Position Controls for Starting: Before attempting to start the diesel engine the controls should be correctly positioned as follows:

1. Normally the compression release lever remains in the RUN position unless it is desired to crank the engine for some purpose other than starting.
2. Disengage or remove any load possible from the engine.



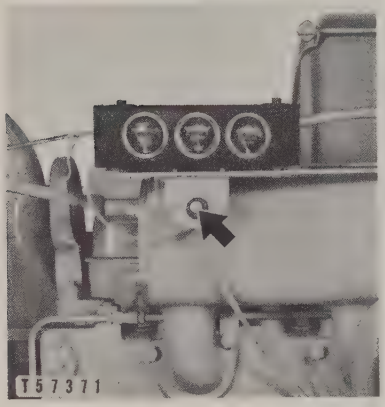
CONTROLS POSITIONED FOR STARTING

1–Compression release lever in RUN position. 2–Governor control lever in approximately half engine speed position.

3. Move the governor control lever to approximately half engine speed position.

Starting the Diesel Engine: After positioning the controls correctly, the diesel engine may be started as follows:

1. Press the starter switch to crank the engine against compression.
2. If the engine does not start in a few seconds, continue to crank the diesel engine but shut off the fuel supply by moving the governor control lever to the shut-off position for about ten seconds to clear the cylinders of raw fuel.



DIESEL ENGINE ELECTRIC STARTER SWITCH

3. If the diesel engine fails to start within **thirty seconds,** release the starter switch and wait **two minutes** to allow the electric starter to cool before using it again.
4. If the electric starter pinion disengages for any reason before the engine starts, release the starter switch and wait until the electric starter stops rotating and the diesel engine stops "rocking" before again pressing the starter switch.

After the diesel engine starts, reduce engine speed to low idle with no load. Do not apply any load to the engine or increase engine speed until normal oil pressure is indicated on the gauge. Avoid unnecessary accelerating of the engine before operating temperatures are obtained. When the gauge indicates normal oil pressure, the engine should be allowed to run for five minutes with the governor control lever at approximately half speed position before applying the load. During this period the engine gauges should be observed for proper readings as explained in the topic, GAUGES.

Air Starting

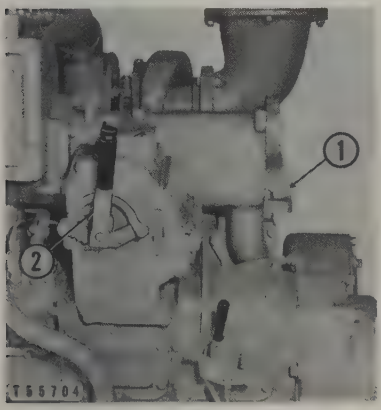
The diesel engine air starter can be used successfully in atmospheric or engine room temperature of 60° F. (16° C.) or above without the use of a starting aid. **It is not advisable** to use the diesel engine air starter in tem-

peratures below 60° F. (16° C.) without the use of a starting aid. See the topic, OPERATING STARTING AIDS. Even when a starting aid is used in temperatures below 32° F. (0° C.), it is advisable to use crankcase lubricating oil of a lower viscosity in the engine crankcase to reduce the cranking effort required. See the topic, CRANKCASE LUBRICATING OIL.

An installation having a 28 cubic feet air receiver with 250 pounds air pressure should provide an adequate volume of air for starting the diesel engine. The air pressure should be regulated to 100 pounds before the air enters the control valve.

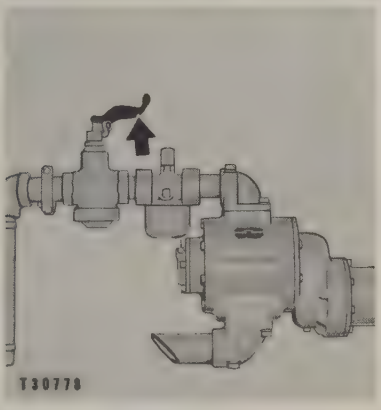
Position Controls for Starting: Before attempting to start the diesel engine the controls should be correctly positioned as follows:

1. Normally the compression release lever **(1)** remains in the RUN position unless it is desired to crank the engine for some purpose other than starting.
2. Disengage or remove any load possible from the engine.
3. Move the governor control lever **(2)** to approximately half engine speed position.



CONTROLS POSITIONED FOR STARTING

1–Compression release lever in RUN position. 2–Governor control lever in approximately half engine speed position.



AIR VALVE CONTROL

Starting the Diesel Engine: After positioning the controls correctly, the diesel engine may be started as follows:

1. Pull up on the air valve control to crank the engine against compression.
2. If the engine does not start in a few seconds, continue to crank the diesel engine but shut off the fuel supply by moving the governor control lever to the shut-off position for about ten seconds to clear the cylinders of raw fuel.

3. If the air starting motor pinion disengages for any reason before the engine starts, release the air valve control and wait until the engine stops "rocking" before again pulling up on the air valve control.

After the diesel engine starts, reduce engine speed to low idle with no load. Do not apply any load to the engine or increase engine speed until normal oil pressure is indicated on the gauge. Avoid unnecessary accelerating of the engine before operating temperatures are obtained. When the gauge indicates normal oil pressure, the engine should be allowed to run for five minutes with the governor control lever at approximately half speed position before applying the load. During this period the engine gauges should be observed for proper readings as explained in the topic, GAUGES.

OPERATING STARTING AIDS

Starting the diesel engine at temperatures above 60° F. (10° C.) using the electric starter, or 60° F. (10° C.) using the air starter, may be accomplished without the use of starting aids as instructed in the preceding topics.

When using the electric or air starting motor in lower temperatures, the glow plug starting aid, the ether starting aid, or both should be used. Starting aids may also be used with the gasoline starting engine method

STARTING AID CHART

STARTING TEMPERATURE	STARTING METHOD	STARTING AID	HEATING TIME OR CAPSULES TO USE
Above 60°F.	Electric	None	None
	Air or Gasoline	None	None
Between 60°F. and 32°F.	Electric or Air	Glow Plugs	1 Minute
		Ether	1 Capsule
	Gasoline	None	None
Between 32°F. and 15°F.	Electric or Air	Glow Plugs	1 to 3 Minutes
		Ether	1 or 2 Capsules
		Glow Plugs and Ether	1 to 2 Minutes and 1 Capsule
	Gasoline	Glow Plugs	1 to 3 Minutes
		Ether	1 Capsule
		Glow Plugs and Ether	1 to 2 Minutes and 1 Capsule
Between 15°F. and –10°F.	Electric, Air or Gasoline	Glow Plugs	3 to 5 Minutes
		Ether	2 Capsules
		Glow Plugs and Ether	and 2 Capsules 3 to 5 Minutes
Below –10°F.	Air or Gasoline	Glow Plugs or Ether, or Both	Heating cooling system and crankcase oil

of starting, however, only experience can determine the temperatures at which the starting aid should be used. The controls should be positioned as instructed in the topic covering the method of starting to be used, and the following additional instructions should be carefully followed. This will permit the quickest possible start and conserve the battery or air supply. See the STARTING AID CHART.

When using glow plugs with either electric or air starting, and the engine fails to start after 10 seconds of cranking, the START switch or air valve control should be released, but continue to hold the HEAT switch in the HEAT position for about 30 seconds before cranking the engine again. When the starting motor is cranking, the battery voltage is reduced and the glow plugs cool. Reheating them after 10 seconds of cranking makes the glow plugs more effective and conserves the battery or air supply.

Do not move the glow plug switch to the ON position while the engine is warm and running.

When using ether for starting, continue cranking until the engine starts. However, do not run the **electric** starter for more than 30 seconds at a time, then allow 2 minutes intermission before using it again.

Starting Between 60° F. and 32° F. Using Glow Plugs: After positioning the controls correctly, the diesel engine may be started as follows. See the topic, GLOW PLUGS.

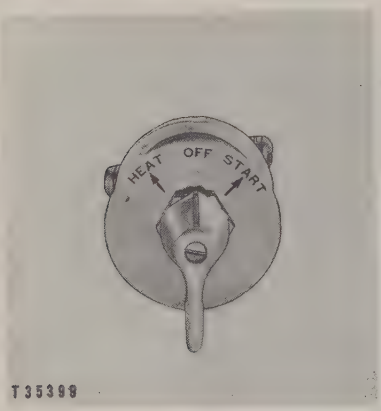
1. Move the HEAT and START switch to the HEAT position, on earlier engines equipped with a HEAT switch and a START switch, move the HEAT switch to ON for the length of time necessary as indicated in the STARTING AID CHART.

NOTE

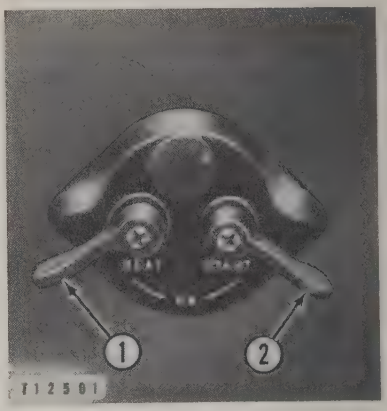
Each glow plug uses approximately 5 amperes while the switch is in the HEAT position. This is actually a small amount in comparison to the starter load that is imposed on the battery when the switch is in the START position.

2. Move the switch to the START position. As soon as the engine starts, move the switch back to the HEAT position until the engine is running smoothly.

If the engine fails to start after 10 seconds of cranking, move the switch to the HEAT position for about 30 seconds before cranking the engine again. When the starting motor is cranking, the battery voltage is reduced and the glow plugs cool. Reheating them after 10 seconds of cranking makes the glow plugs more effective and conserves the battery. **Do not move the switch to the HEAT position while the engine is warm and running.**



HEAT AND START SWITCH
(Later Engines)



CONTROL SWITCHES
(Earlier Engines)
1–HEAT switch. 2–START switch.

After the engine starts place the high-low selector lever in engaged position so the transmission oil pump will be in operation. The engine should be allowed to warm up for five minutes with the accelerator at approximately half speed position before applying the load. When the diesel engine starts, the starter pinion automatically disengages. See the topic, GAUGES.

Starting the Diesel Engine Below 32° F. Using Glow Plugs and Ether Starting Aid: After positioning the controls correctly, the diesel engine may be started as follows. See the topics, GLOW PLUGS and ETHER STARTING AID.

1. Load the discharger by unscrewing the nut **(2)**, removing the spent capsule and placing the new capsule **(3)** in the discharger as shown. Install the nut finger tight.
2. Move the HEAT and START switch to the HEAT position for the length of time necessary as indicated in the STARTING AID CHART.

NOTE

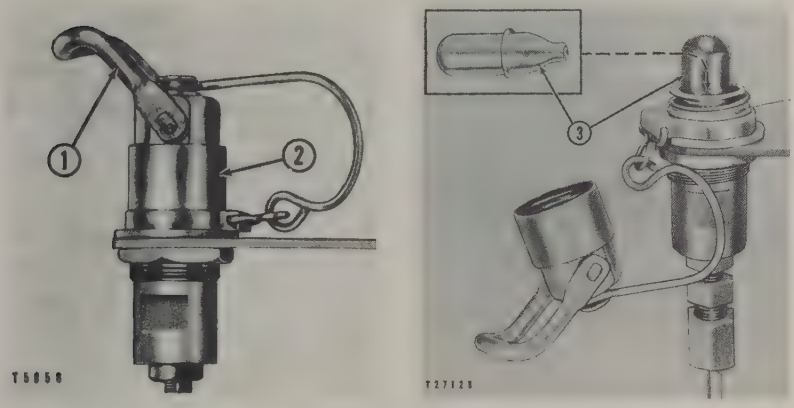
Each glow plug uses approximately 5 amperes while the switch is in the HEAT position. This is actually a small amount in comparison to the starter load that is imposed on the battery when the switch is in the START position.

3. Discharge ether by moving the discharger lever **(1)** to pierce the capsule. See the STARTING AID CHART for the number of capsules required.

   Be sure the spent capsule is left in the discharger when the engine is running and the nut **(2)** is finger tight on the discharger to keep dirt out of the engine.

Actual experience will determine the number of capsules required for easy starting.

If more than one capsule is needed in the manifold, discharge the first two capsules and install the second set of capsules in the dischargers before cranking the diesel engine. Only one or two capsules should be discharged into the manifold before cranking the



ETHER DISCHARGER
1–Discharging lever. 2–Nut. 3–Capsule.

engine. The discharge of the second set of capsules can be performed when the engine has been cranked a few revolutions, or when it starts to stall.

4. Move the switch to the START position. As soon as the engine starts release the switch and discharge ether capsules as required to prevent stalling, until the engine is running smoothly. **Do not move the switch to the HEAT position while the engine is warm and running.** If the engine does not start after 10 seconds of cranking, turn the switch to the HEAT position for 30 seconds, then repeat the starting procedure.

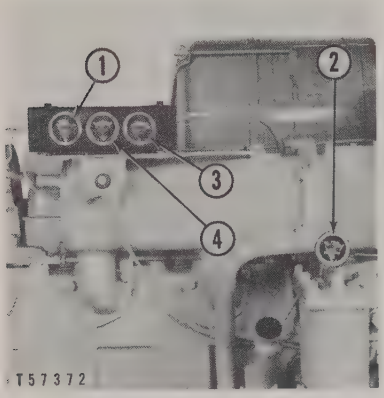
After the engine starts place the high-low selector lever in engaged position so the transmission oil pump will be in operation. The engine should be allowed to warm up for five minutes with the accelerator at approximately half speed position before applying the load. When the diesel engine starts, the starter pinion automatically disengages. See the topic, GAUGES.

CAUTION

Do not discharge more than 2 ether capsules without cranking the engine.

GAUGES

During the engine warm-up period and at frequent intervals while the engine is operating, the engine gauges should be observed for proper readings as explained in the following paragraphs:



GAUGES

1–Water temperature gauge. 2–Fuel pressure gauge. 3–Crankcase lubricating oil pressure gauge. 4–Ammeter.

Oil Pressure Gauge: Immediately after the engine has started, check the crankcase lubricating oil pressure gauge **(3)** to see that it is registering. When the engine is running at rated engine speed the gauge should register in the "Operating Range." A lower pressure reading is normal at low idling speeds. If no pressure is indicated, investigate at once.

Water Temperature Gauge: The indicator on the water temperature gauge **(1)** should register in the "Operating Range". The water temperature regulators within the diesel engine cooling system are designed to give an approximate minimum coolant temperature of 160° F. (71° C.). The maximum operating temperature will vary according to the air temperature and load factor, but should never exceed boiling temperature at the prevailing altitude.

Fuel Pressure Gauge: The indicator on the fuel pressure gauge **(2)** should register in the NORMAL (white) range. See the topic, CARE OF THE FUEL FILTER.

Ammeter: On engines equipped with a charging generator the ammeter should be checked to see that the indicator is registering in the charging range (indicator on the + side of zero). If the indicator registers in the discharging range (indicator on the — side of zero) investigate at once. If the ammeter shows no charge it may be that the circuit breaker is open. To close the circuit breaker press the reset button and again check the ammeter to see if it is registering in the charging range. When it is necessary to close the circuit breaker after each start, it indicates the voltage regulator is not functioning properly. See the topic, GENERATOR REGULATOR.

STARTING THE LOAD

When the engine has run long enough to warm up, move the governor control lever to the full governed speed position to bring the engine to operating speed. Move the flywheel clutch lever forward slowly, and after the load has started, push the clutch lever firmly until it snaps over center.

STOPPING THE LOAD

For a temporary stop — that is, when it becomes necessary to stop transmitting power — remove the load and move the governor control lever to reduce the engine speed. Reduce engine speed as described in the topic, STOPPING THE DIESEL ENGINE.

STOPPING THE DIESEL ENGINE

Correctly stopping the diesel engine will allow some of the hot areas in the engine to gradually cool, thus extending engine service life. The correct diesel engine stopping procedure is as follows:

1. After the normal load is removed from the engine allow it to idle five minutes with the governor control lever at half engine speed position.
2. Reduce engine speed to low idle speed and allow the engine to run for thirty seconds.
3. Stop the diesel engine while it is running at low idle speed by moving the governor control lever to the shut-off position. Do not accelerate the engine speed above low idle before stopping the engine.

If the engine must stand without shelter, cover the exhaust pipe (including starting engine exhaust pipe if so equipped) to exclude rain or snow. A rain trap for this purpose may be obtained from your Caterpillar dealer. If the temperature is below freezing, or if freezing weather is expected before the engine will be started again, drain the cooling system or protect it with an anti-freeze solution. See the topic, COOLING SYSTEM, for information about anti-freeze solutions and cooling system draining.

DAILY CARE

Attention should be given to the operations mentioned in this topic, every 10 service hours or daily, whichever occurs first.

A daily check of the engine should be made to see if there are any loose nuts, bolts or parts worn to such an extent that they are no longer serviceable. If corrective steps are taken immediately on discovery of loose or worn parts, fewer forced stops and more economical operation will result. Points to be checked daily, or every 10 service hours, are as follows:

1. Exhaust and inlet manifold, turbocharger mounting bolts and air cleaner connections, inspect for tightness. The manifolds should be air tight.
2. The turbocharger oil supply inlet tube should be checked to be sure oil leakage is not present.
3. Check the operation of the turbocharger to see that no vibration or noise is present. The "muffled high pitch whine" is the normal sound of the turbocharger. If the turbocharger is defective, it will usually be noisy only under load.
4. Cooling system, add coolant or anti-freeze if necessary. Be sure the filler cap seal is in good condition and that the cap is installed tightly.
5. Fuel pressure gauge, inspect with engine running to see that indicator is not in red range.
6. Diesel engine air cleaner cup, when operating conditions are extremely dusty, inspect for dirt in cleaner cup with the engine stopped.

Fill the fuel tank at the end of the day's run. See the topic, CARE OF THE FUEL SUPPLY TANK for other periodic care.

Dirt should not be allowed to accumulate on the engine. A few minutes spent daily in keeping it clean are well repaid in improved appearance and greater ease and safety of operation, lubrication and maintenance.

When the diesel engine is operating continuously, the starting engine should be run for a few minutes each day to dissipate condensation and renew the oil film on the bearing surfaces and cylinder walls.

STARTING IN COLD WEATHER

If the electrical system, starting engine and the diesel engine are all in good condition, and the precautions necessary for cold weather operation are taken, ordinary cold weather will not cause difficulty in starting or loss of efficiency.

Lubricants: As the starting atmospheric temperatures become lower, where warm housing facilities are not available, lubricants of lower viscosity should be used. See the topic, TYPE OF LUBRICANTS AND SAE GRADES TO USE.

It is very important to keep low viscosity crankcase lubricating oil up to the full mark on the gauge in the diesel engine crankcase to provide proper lubrication when starting. Refer to the topic, CRANKCASE LUBRICATING OIL.

Coolant: When the temperature is below freezing, sufficient anti-freeze solution should be used in the cooling system to prevent freezing. See the topic, COOLING SYSTEM.

The liquid in the cooling system may be warmed to make starting easier and quicker. When warming anti-freeze solutions, keep away from flames, as some of these solutions may be inflammable. Avoid getting the solution hot, and even a warm solution should be poured very slowly into a cold cooling system to prevent damage by sudden expansion.

Fuel: Fuel must be "free flowing" enough to flow readily through the fuel lines at the lowest temperature at which the engine will be started and operated. For additional information, see the topic, FUELS.

Electrical Equipment: During cold weather, more attention should be given the condition of the battery. It should be tested frequently and charged as often as necessary to insure sufficient power for starting. All switches and connections in the electrical system should be inspected and kept in good condition to prevent losses through improper contacts. See the topic, BATTERY CARE.

Starting the Starting Engine: If the engine has been standing without shelter in extremely cold weather, the suggestions that follow will materially assist starting, as well as protect the engine against damage.

It is very important to keep low viscosity crankcase lubricating oil up to the full mark on the gauges in both the diesel engine and starting engine to provide proper lubrication when starting. Refer to the topic, TYPE OF LUBRICANTS AND SAE GRADES TO USE.

Crank the starting engine several revolutions with the mangeto switch OFF, the choke ON, the throttle slightly open and the starting engine clutch disengaged. This will prime the engine and better distribute oil to the bearings and cylinder walls.

Sometimes moisture, or fuel which has not vaporized, collects on the starting engine spark plugs. They may be dried out by removing them and pouring gasoline over the electrodes. Ignite the gasoline and allow it to burn. **Use care to prevent fire.**

Pouring a small amount of gasoline on the electrodes before they are replaced in the engine is more effective in promoting combustion than priming the cylinders with raw gasoline. A small amount of raw gasoline in the cylinders will remove the film of oil from the cylinder walls and interfere with compression.

Follow the starting procedure covered in the topics, GASOLINE STARTING and either MANUAL STARTING or ELECTRIC STARTING whichever applies.

Sometimes the starting engine can be started more quickly by pulling out the throttle control. **When the engine starts push in the throttle to the idling position to keep the engine speed low until the crankcase lubricating oil has a chance to warm up and better lubricate the engine.**

Starting the Diesel Engine: It is very important to keep low viscosity crankcase lubricating oil up to the full mark on the gauge in the diesel engine crankcase to provide proper lubrication when starting. Refer to the topic, TYPE OF LUBRICANTS AND SAE GRADES TO USE.

In cold weather, if the pinion clashes and will not engage with the ring gear proceed as follows:

1. Stop the starting engine after the lubricating oil is thoroughly warm.
2. Engage the starter pinion and starting engine clutch. (It may be necessary to rotate the starter pinion by the use of the electric starter or hand crank.)
3. Disengage the starting engine clutch by pushing the control lever to the rear.
4. Restart the starting engine.
5. With the starting engine running at high idle speed, engage the starting engine clutch to start the diesel engine.

When the engine starts, keep the engine speed low until the crankcase lubricating oil has a chance to get warm and better lubricate the engine.

STORAGE

Lubricate all points mentioned in the lubrication chart if the engine is to be stored or left standing for any length of time. This will protect against rusting.

Diesel Engine: If the engine is to be stored or left standing for a long period of time, the lubricating oil may drain away from the cylinder walls and piston rings. This lack of lubricant permits the rings and liners to rust. It also permits unnecessary wear caused by metal-to-metal contact between the pistons, rings and liners when the engine is started before fresh oil has reached these surfaces. The lack of lubricant may not cause any noticeable change in engine operation after it has been started but it does contribute to shorter engine life.

On the diesel engine the oil film should be renewed by running the engine once a week until it is thoroughly warm. This will circulate the oil and prevent rusting from condensation.

Starting Engine: The oil film should be renewed in the starting engine by running the engine once a week until it is thoroughly warm.

Cooling System: If the temperature will be below freezing the cooling system should be drained if it has not been serviced as instructed in the topic, COOLING SYSTEM.

Battery: Periods of two weeks or more when the engine is not operated necessitates provisions being made to keep the battery charged. This may be done by running the engine once a week or taking the battery to your Caterpillar dealer for charging.

When replacing a battery that has been removed, make certain the correct battery post is connected to the ground cable. Failure to connect the battery terminal to the correct post will damage the voltage regulator. See the topic, WIRING DIAGRAMS.

ALTITUDE OPERATION

The maximum turbocharger speed is determined by the fuel rack setting, the high idle speed, the turbine nozzle and the altitude at which the engine is operated. The rack and high idle speed settings have been established to permit the engine to be operated at the altitude marked on the warning plate on the aftercooler. The turbine nozzle is the same for all altitudes, but the engine fuel rack setting and high idle speed vary with altitude. If the fuel rack setting is greater than specified for the altitude at which the engine is being operated or the high idle speed is too high, **serious damage or injury due to turbocharger overspeeding may result.**

The maximum altitude at which the engine may be operated at the present setting is marked on the warning plate on the aftercooler. The governor housing and turbocharger are sealed for your protection. **Changes to the turbocharger, fuel rack setting, or high idle speed should be made only by your Caterpillar dealer.**

The engine can be operated at a lower altitude than marked on the warning plate without danger of turbocharger overspeeding, but with slightly less than maximum performance, however the fuel rack setting must be changed when operating at a lower altitude to get full power. **When operated at a higher altitude, the fuel rack setting must be changed by your Caterpillar dealer.** After making any changes, the new altitude limit will be marked on the warning plate and the governor housing will be re-sealed for your protection. This will assure you correct settings have been made.

IMPORTANT: Consult your Caterpillar dealer before operating at a higher altitude than is marked on the warning plate.

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Maintenance Instructions

The foregoing paragraphs have been devoted to instructions which are necessary for day-to-day operation of the engine. The following topics give detailed instructions regarding the care and adjustment of the various parts.

AIR CLEANERS

Later engines are equipped with one of two types of single element dry type air cleaners. Earlier engines are equipped with either a two stage dry type air cleaner or an oil bath type air cleaner. Maintenance instructions for each type of air cleaner are given.

Diesel Engine Dry Type Air Cleaner

The dry type air cleaners are to be used without oil.

Regular service intervals, along with close visual inspection of the dry type air cleaner, are necessary for proper cleaning of the engine inlet air. The service interval will vary with the weather and working conditions. During dry, dusty months where dust conditions are severe, it will be necessary to service the air cleaner frequently. In damp weather and other conditions of little or no dust, the service interval can be extended.

If desired, the air cleaner service periods can be determined by measuring the air cleaner restriction with a manometer, a vacuum gauge or with the installation of an Air Cleaner Service Indicator in the air transfer pipe between the air cleaner and turbocharger. The air cleaner should be serviced when the restriction reaches 30 inches of water when measured with a manometer or vacuum gauge or when the red piston locks in the "up" position on an Air Cleaner Service Indicator. All checks should be made at high idle engine speed (turbocharged engines at rated speed and full load). This measurement of restriction should be made with an element that shows no evidence of damage to the sealing surfaces or resin impregnated cellulose material.

Excessive engine exhaust smoke and/or loss of power may indicate the need for servicing the air cleaner.

To extend the service life of the element, the exhaust and air cleaner inlet pipes should be arranged so that exhaust and/or oil fumes do not enter the engine air cleaner.

Visual inspection of the gaskets, seals and filter elements is important in keeping dust from by-passing the air cleaner. Air leakage can upset proper air cleaner action. If the condition of any of the replaceable seals and gaskets is questionable, replace them. If the sealing ends of the filter element or the element pleats are damaged, replace the element. The

end caps of the filter element can be damaged by bumping or tapping. Bent and/or dented end caps cannot seal properly and will allow unfiltered air to enter the engine cylinders causing premature engine wear.

An extra filter element should be kept on hand for replacement or for use in the air cleaner while the element that was removed is being cleaned.

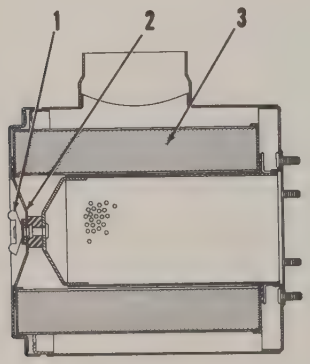
Single Stage Air Cleaner

Every 50 to 250 service hours, in average operating conditions, remove the filter element for inspection and cleaning. This period may be extended in clean atmosphere and can only be determined by experience. **Never service the air cleaner with the engine running.**

1. To remove the filter element (Type 1) unscrew wing nut **(1)**, remove end cover **(2)** and filter element **(3)**.

On earlier (Type 1) air cleaners, loosen the wing screw **(1)**, take off the clamp ring and remove the end cover **(2)**. Unscrew the wing nut **(4)** and remove the plate and filter element **(3)**.

The (Type 2) single element air cleaners are similar. To remove the filter element **(3)**, loosen the two wing nuts **(1)**, remove the end cover **(2)** and the filter element.



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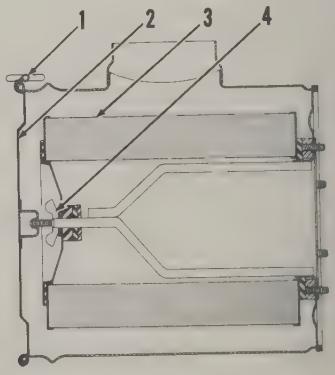

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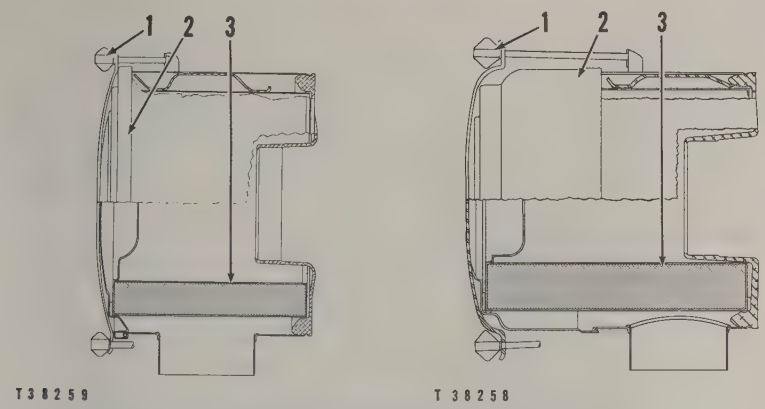
SINGLE STAGE DRY TYPE AIR CLEANER (Type 1)

1–Wing nut. 2–End cover. 3–Filter element.

(Early Model)

1–Wing screw. 2–End cover. 3–Filter element. 4–Wing nut.

2. Remove any dirt which has accumulated on the bottom of the case and clean the filter element using one of the methods covered in the topic, FILTER ELEMENT CLEANING.

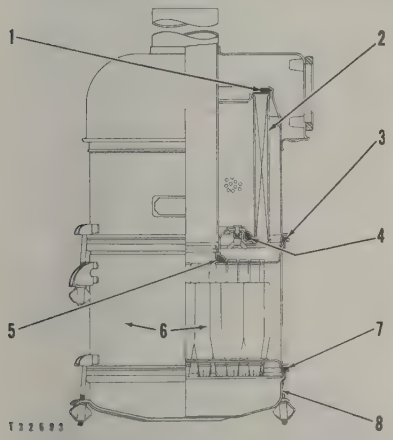


SINGLE STAGE DRY TYPE AIR CLEANER
(Type 2)
1–Wing nut. 2–End cover. 3–Filter element.

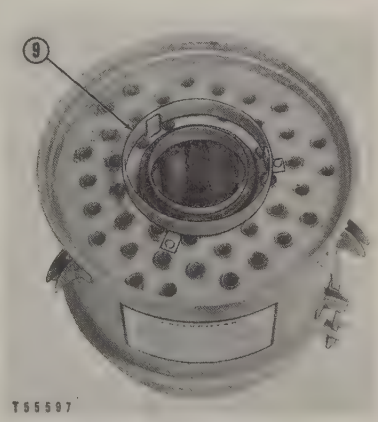
Two Stage Air Cleaner

Dust Collector Cup: Every 10 to 50 service hours remove the dust collector cup.

1. Loosen the wing nuts and remove the dust collector cup **(8)**.



TWO STAGE DRY TYPE AIR CLEANER
1–Element upper seal. 2–Filter element. 3–Upper body seal. 4–Element lower seal. 5–Lower body gasket. 6–Lower body. 7–Lower body seal. 8–Dust collector cup.



FILTER ELEMENT WING NUT LOCKING RING
9–Locking ring.

2. Empty the dust from the dust collector cup.
3. Inspect the lower body seal **(7)**, replace if necessary, and install the dust collector cup. Use no oil in the dust collector cup.

Lower Body: Inspect the lower body every 10 to 50 service hours when the dust collector cup is removed. If an accumulation of dirt is found in the tubes, they should be cleaned by pushing a round bottle brush, through the tubes from the bottom. It is not necessary to remove the lower body except when filter element inspection and cleaning is desired. When the lower body is removed it should be thoroughly cleaned.

1. Loosen the wing nuts and remove the lower body **(6)**.
2. Thoroughly clean the tubes.
3. While the lower body is removed for cleaning inspect the air cleaner inlet tube and remove any accumulation of dust.
4. Inspect the upper body seal **(3)** and lower body gasket **(5)**, replace them if they are damaged.

Filter Element: Every 125 to 250 service hours, depending on operating conditions, remove the filter element for inspection and cleaning. This period may be extended in clean atmosphere and can only be determined by experience.

1. Remove the dust collector cup and lower body.
2. Remove the wing nuts and the filter element **(2)**.
3. Clean the filter element by using one of the methods in the topic FILTER ELEMENT CLEANING.
4. Inspect the element. If the upper seal **(1)** and lower seal **(4)** which are on the element or the element are damaged install a new filter element.
5. Thoroughly clean all parts of the air cleaner. Inspect all replaceable seals **(3)** and **(7)** and gasket **(5)** and replace with new ones if damaged.
6. Install the filter element and the filter element retaining wing nuts. Tighten the wing nuts securely to prevent dust from by-passing the air cleaner filter element.
7. Align the filter element retaining wing nuts so locking ring **(9)** will slip over the wing nuts, when the lower body is installed, to prevent the wing nuts from turning.
8. Make sure upper body seal **(3)** and lower body gasket **(5)** are in place, and install the lower body. Complete the assembly by installing the dust collector cup. This type of air cleaner requires no oil.

If after cleaning, the engine exhaust smoking and/or loss of power has not been corrected, or the restriction has not been reduced, replace with a new element.

Replace the filter element at least once a year.

Filter Element Cleaning

Clean the filter element using one of the following methods:

1. Using clean, dry air, at a pressure not to exceed 100 PSI, proceed as follows:

   Direct air against the inside of the element to loosen any imbedded dirt. Best results can be obtained by moving the air hose so that air is directed along the complete length of each pleat.

   Blow off loose dirt by directing air against the outside of the element. Repeat this procedure until the element is clean. Make certain that no dirt is inside the element.

2. Using clean water, at a pressure not to exceed 40 PSI, proceed as follows:

   Direct water against the inside of the element to loosen any imbedded dirt. Best results can be obtained by using a water hose without a nozzle and moving it so that water is directed along the element.

   Wash off loose dirt by directing water against the outside of the element.

   Repeat this procedure until the element is clean. Make certain that no dirt is inside the element, and thoroughly dry the element before installing it.

3. Some oily and/or sooty deposits can be removed by washing the element in a solution of warm water and a good household non-sudsing detergent. Rinse with clean water and dry as in "2" above.

Diesel Engine Oil Bath Type Air Cleaner

The air cleaners do their work efficiently only as long as the oil in the cups is thin enough to flow freely, so it will spray into the filter section and wash back the dirt collecting there. For this reason, air cleaners should be inspected frequently and serviced according to the following instructions.

Inspect the Oil in the Diesel and Starting Engine Air Cleaner Cups: Every 10 to 50 service hours, depending upon operating conditions, inspect the oil in the diesel engine air cleaner cup. The air cleaner cup should be washed and refilled every 50 service hours or when the oil in the cup will not flow freely at operating temperature, or if the sediment in the cup is 1/2 inch deep (1/4 inch in a starting engine air cleaner), whichever occurs first. It may be necessary to inspect the oil in the starting engine air cleaner cup every 50 service hours.

1. Loosen the wing nuts and take off the diesel engine air cleaner cup and separable tray.

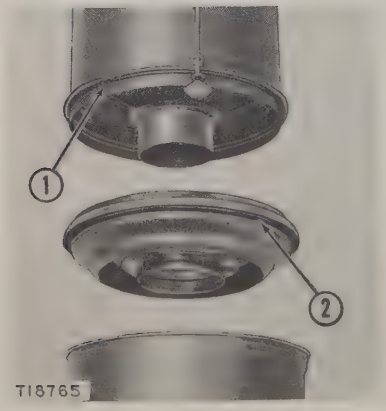
   a. On starting engine air cleaners the oil cup is removed by loosening the screw clamp.

Some thickening of the oil in the cup should be no cause for alarm, actually it can be considerably thicker than the SAE grade that was last put in the cup, as long as the oil will flow freely. For a check to determine if the oil will flow freely, dip into the oil with a finger and if the oil on it will flow off, the oil is fluid enough to flow freely.

2. Service other parts of the air cleaner while the oil cup is removed, as indicated in the following topics.

3. When refilling the oil cup, care should be taken to see that both the inner and outer cups are filled to the flat face of the inner cup and to the oil level bead on the starting engine air cleaner cup. In temperatures above freezing SAE 30 oil should be used. In temperatures below freezing use SAE 10W oil. Do not dilute SAE 10W oil.

4. Seals between the cup, separable tray and body prevent oil running out of the cup during angular operations. Air leakage at this point can possibly upset proper air cleaner action. When replacing the oil cup and separable tray on air cleaners, check to see that the seal **(2)** between the air cleaner cup and separable tray and the seal **(1)**



AIR CLEANER SEALS

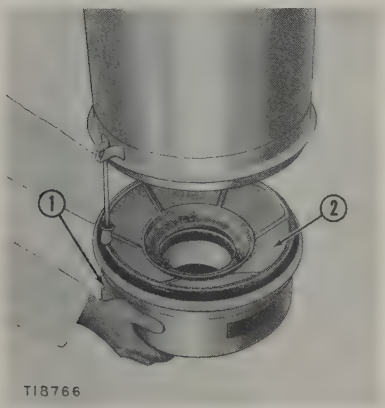
1–Seal. 2–Seal.

between the separable tray and body are in place and in good condition.

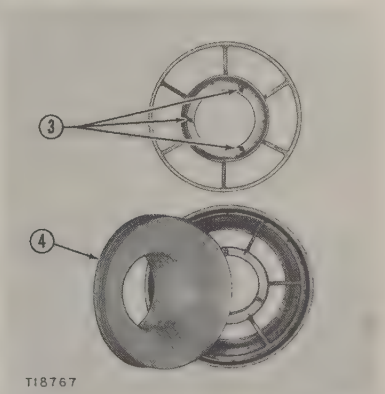
Never attempt to change the oil in the air cleaner cup when the engine is running. This will cause dirty oil to be held in the filter section by intake action. The dirty oil held in the filter section will contaminate the fresh oil and also cause an abnormally high oil level which may allow oil in the screens to be carried into the engine resulting in overspeeding.

Wash Air Cleaner Lower Filter Section: At every air cleaner cup service period between 10 and 50 service hours depending on operating conditions, wash the separable tray screens.

1. Remove the separable tray **(2)** and cup **(1)** by loosening the wing nuts that hold them in place.
2. Turn the cup slightly and remove it with the tray from the air cleaner body.



REMOVING AIR CLEANER CUP AND SEPARABLE TRAY
1–Cup. 2–Separable tray.



AIR CLEANER SEPARABLE TRAY DISASSEMBLED
3–Thumb screws. 4–Screens.

3. Disassemble the separable tray by loosening the thumb screws **(3)** and lift out the screens.
4. Wash the separable tray screens with a brush in kerosene or some nonflammable cleaning fluid.
5. Assemble the separate tray by placing the screens **(4)** in the tray, and tightening the thumb screws.
6. Assemble the separable tray and cup to the air cleaner body.
7. Make sure all connections are tight.

Inspect the Inside of the Air Cleaner Inlet Pipe: Every 10 to 50 service hours, depending on operating conditions, when the air cleaner cup is removed to clean the separable tray screens, inspect the inside of the air

cleaner inlet pipe by reaching up from the bottom of the pipe. If a heavy accumulation of dirt is noticed, clean the pipe.

Inspect the Air Cleaner Upper Filter Section: Inspect the bottom screen of the air cleaner upper filter section whenever chaff, lint, leaves or other such material shows up in the oil or in the separable tray. This material must be cleaned out to maintain proper air cleaner performance.

Wash the Entire Air Cleaner: Every 2000 service hours — more often in dusty conditions — wash the entire air cleaner.

1. The entire air cleaner should be removed from its support in order to thoroughly clean the upper filter section in the cleaner body.
2. Remove the oil cup and separable tray.
3. Immerse the entire cleaner in kerosene or some non-inflammable cleaning fluid. Steam cleaning is not recommended because some forms of dust rolls into small balls when steam is applied, and these balls cannot be washed out of the screens.
4. Wash the oil cup and separable tray as outlined in the preceding topics.
5. Dry the air cleaner parts thoroughly and reassemble them, making certain all connections are air tight.

Starting Engine Dry Type Air Cleaner

Every 250 service hours clean the filter element. The element may have to be cleaned oftener under dusty conditions or whenever hard starting and/or loss of speed and power is observed. To service the element proceed as follows:

1. Unscrew the wing nuts **(1)** which retain the assembly.
2. Remove the air cleaner cover plate **(2)** and the filter element **(3)**.

AIR CLEANER ASSEMBLY

1–Wing nut. 2–Cover plate. 3–Filter element.

3. Clean the element by directing clean dry air under pressure (not to exceed 100 PSI) against the inside of the element forcing air through the element to the outside. Do not let dust collect on the inside of the element.

4. While the filter is removed inspect and clean all parts of the cleaner before assembly.

If the element is damaged or if after cleaning, the engine is hard to start and/or loss of power has not been corrected, install a new Caterpillar element.

Replace the filter element at least once a year.

Starting Engine Oil Type Air Cleaner

Wash Starting Engine Air Cleaner: Every 1000 service hours wash the starting engine air cleaner.

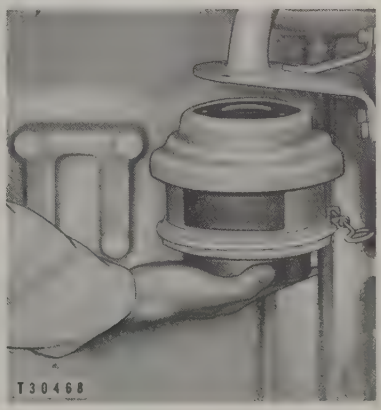
1. Loosen the screw clamp and remove the oil cup.

2. Remove the cleaner body by taking out the capscrews at the top of the cleaner.

3. Wash the filter by shaking the air cleaner body in a pan of kerosene or some nonflammable cleaning fluid.

4. Wash and refill the oil cup.

REMOVING STARTING ENGINE AIR CLEANER



5. Assemble and install the air cleaner, but be sure the mating faces of the air cleaner and the cleaner pipe are clean, the gasket beween them is in place and all connections are air tight.

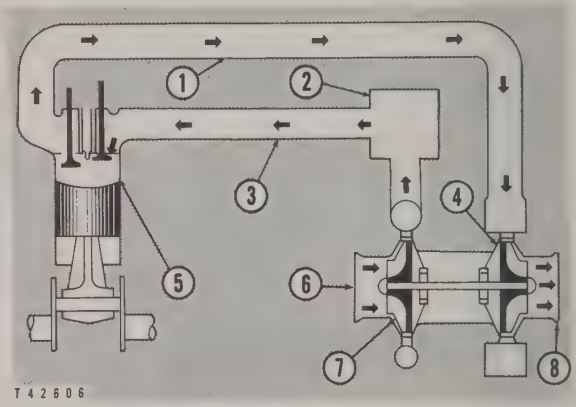
Precleaner Care: The precleaner is recommended to lengthen air cleaner service periods because it removes some of the dirt from the inlet air. For this reason, always install the jar correctly and replace either a broken jar or gasket immediately, because the precleaner will

not work properly without them. Remove and empty the jar before it becomes three-fourths full by loosening the clamp bolt that holds it in place. Inspect the fins in the precleaner regularly and when they are dirty remove the entire precleaner and wash it in water.

TURBOCHARGER

General: The engine is equipped with a turbocharger which is driven by exhaust gases. The turbocharger is located on top of the center section of the diesel engine exhaust manifold.

On engines not equipped with turbochargers air enters the cylinder under approximately atmospheric pressure when the piston travels down-

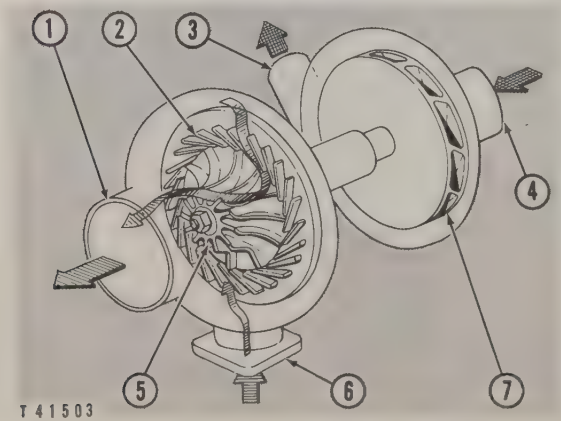


SCHEMATIC OF AIR INDUCTION AND EXHAUST GAS TURBOCHARGING SYSTEM

1–Exhaust manifold. 2–Aftercooler. 3–Inlet manifold. 4–Turbine. 5–Engine cylinder. 6–Air inlet. 7–Compressor. 8–Exhaust gas discharge.

ward on the inlet stroke. When the turbocharger is used, the air in the inlet manifold is under greater pressure than atmospheric, and air is forced into the cylinders, thus permitting more fuel to be burned. This results in greater horsepower output than from an engine of the same dimension that is not equipped with a turbocharger.

The aftercooler installed in the inlet manifold between the turbocharger and the engine cylinders will cool the pressurized air entering the engine



TURBOCHARGER EXHAUST GAS AND AIR FLOW

1–Exhaust gas outlet. 2–Turbine nozzle. 3–Compressed air discharge. 4–Air inlet. 5–Turbine wheel. 6–Exhaust gas inlet. 7–Compressor impeller.

cylinders and deliver an air charge of greater density. Cooler pressurized air will allow an even greater amount of fuel to be burned thereby further increasing the horsepower output of a turbocharged engine.

The turbocharger is constructed with such close limits of balance and clearances that foreign particles may affect its operation. If any unusual sound or vibration resulting from the turbocharger operation is noticed, the engine should be stopped and the turbocharger inspected. Whenever a turbocharger is removed from an engine, the exhaust and inlet manifolds and oil line openings should be covered to prevent entrance of dirt.

Lubrication: The turbocharger is lubricated with oil supplied from the diesel engine crankcase lubricating oil system. On later engines, the oil passes through a tube from the crankcase lubricating oil filters to the turbocharger. On earlier engines, this oil passes through a separate full-flow filter which is in addition to the standard full-flow filter for the engine. After lubricating the turbocharger bearings, the oil then returns to the diesel engine crankcase by gravity. Care of the turbocharger oil filter is covered in the topic, TURBOCHARGER OIL FILTER.

TURBOCHARGER CLEANING

Engines effective with 46B599 are equipped with new open impeller type turbochargers which require cleaning only when the turbocharger is disassembled. Earlier engines may also be equipped with these turbochargers, which can be identified by the one-piece center housing.

On earlier engines which are not equipped with new type turbochargers, deposits of foreign material which gradually accumulate on the turbocharger compressor impeller must be removed periodically. Excessive deposits will flake off, impairing the balance of the impeller and possibly resulting in serious damage. The service intervals at which cleaning is necessary will depend upon operating conditions, but the impeller should be inspected at least every 500 service hours.

If any unusual sound, such as an abnormal squeal, is heard in the turbocharger, stop the engine at once. Check for excessive clearance in the turbocharger bearings and clean the impeller if noticeable deposits have accumulated. If the bearings permit more than a perceptible movement of either or both ends of the rotating assembly which consists basically of the impeller, turbine and shaft, or if squealing persists after cleaning, see your Caterpillar dealer.

Since a small amount of water may enter the crankcase during the cleaning process, it is advisable to perform this maintenance just before a crankcase lubricating oil change period if possible.

Equipment for cleaning the turbocharger impeller is available from your Caterpillar dealer at nominal cost.

The following cleaning procedure is recommended for earlier turbochargers having closed impellers.

1. Remove the air inlet and outlet piping from the compressor housing **(1)**.

2. Working through the inlet opening **(2)**, use a toothbrush or similar small, stiff bristled brush to clean the dirt from the impeller **(4)** and housing. Care must be taken to avoid nicking or scratching the impeller.

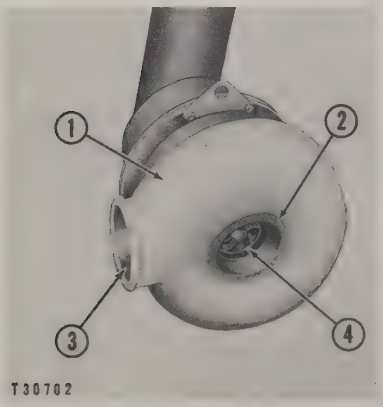
3. Assemble the hose on the adapters using hose clamps **(7)**, and install the elbow adapter **(8)** in the compressor housing inlet.

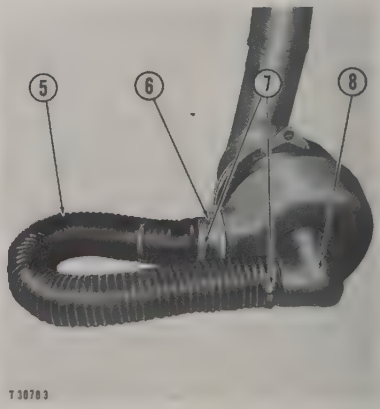
NOTE

If turbocharger cleaning is to be carried out in dusty surroundings, a length of flexible hose should be used between the air cleaner and the diesel engine inlet manifold to prevent dust laden air from being drawn into the diesel engine.

4. Mix **no more than** one gallon of clean water with one cup of a low-sudsing, household detergent. Pour this mixture into the end of the hose **(5)**. The mixture may be allowed to run into the compressor housing before installing the end of the straight adapter **(6)** in the compressor housing outlet **(3)**.

5. Start the diesel engine and operate at high idle speed for ten minutes. Avoid placing any load on the engine during this cleaning cycle. Flexible hose should be handled carefully to prevent snagging or damage to the hose.





CLEANING THE TURBOCHARGER

1–Compressor housing. 2–Compressor inlet. 3–Compressor outlet. 4–Impeller. 5–Flexible hose. 6–Straight adapter. 7–Hose clamps. 8–Elbow adapter.

6. Stop the engine and remove the elbow adapter from the inlet side of the compressor housing. Carefully inspect the impeller for cleanliness. If not clean, brush loose any remaining deposits. Restart the engine and operate at high idle speed for five minutes. This inspection and cleaning procedure should be repeated until the impeller is **thoroughly** cleaned. When the inside diameter of the impeller shroud is free from all deposits, the cleaning job is completed. **Partial cleaning can result in as serious or more serious turbocharger rotating assembly unbalance than if no cleaning were attempted.**
7. When the impeller is clean, drain the water-detergent solution from the hose. Start the engine again and blow the dirt and water out of the turbocharger compressor housing.

CAUTION

Since water and foreign material will be blown for considerable distance out of the free end of the hose connected to the turbocharger compressor outlet, the free end of the hose should be directed so that the solution will be ejected into an area which cannot be damaged by it.

8. Remove the flexible hose and adapters and reinstall the air inlet and outlet piping to the compressor housing using four new O-ring seals.

CRANKCASE LUBRICATING OIL SYSTEM

The crankcase lubricating oil flows from the oil pump, located in the crankcase, to the oil cooler where it is cooled; then flows to the oil filter base, through the filters and then is distributed to the bearings and all points of lubrication in the engine.

The oil is cleaned by a full-flow filtering system incorporating two filter elements. These filters, located on the right side of the engine, are installed in the main pressure line so that the entire pump capacity is put through these units.

The turbocharger is lubricated with oil supplied from the diesel engine crankcase lubricating oil system. A turbocharger lubrication valve is used to assure rapid distribution of crankcase lubricating oil to the turbocharger when the engine is being started. The valve is in the lubricating oil system between the crankcase lubricating oil pump and the oil cooler. After lubricating the turbocharger bearings, the oil then returns to the diesel engine crankcase by gravity.

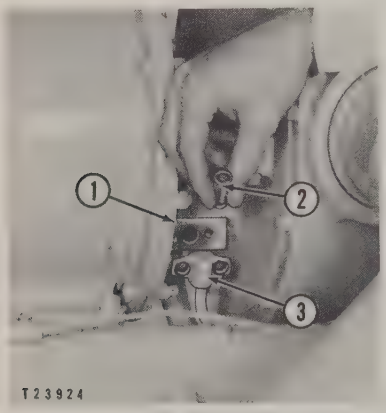
Engines before 46B1 are not equipped with a turbocharger lubrication valve unless a "Turbocharger Oil Lines and Valve Group" has been added.

The crankcase lubricating oil filter should be replaced periodically. See the LUBRICATION INSTRUCTIONS section of this book.

Turbocharger Oil Filter: Earlier engines are equipped with a separate filter for the turbocharger lubricating oil. On these engines, the oil is filtered a second time by the turbocharger full flow filter that is mounted on the right side of the engine. The turbocharger oil filter housing contains one filter element. The filter element should be replaced with a new Caterpillar element every 500 service hours. See the section LUBRICATION INSTRUCTIONS of this book.

Turbocharger Oil Strainer: Later engines are not equipped with a turbocharger oil strainer. On earlier engines equipped with a turbocharger oil strainer, remove the strainer at the first opportunity and discard it. To remove the strainer proceed as follows:

1. Thoroughly clean around the connection and then disconnect the oil pressure line **(3)** from the adapter **(1)**.
2. Remove the strainer **(2)** and discard it.
3. Reconnect the oil pressure line to the adapter.



TURBOCHARGER OIL STRAINER

1–Adapter. 2–Strainer. 3–Oil pressure line.

Washing the Crankcase: Whenever the diesel or starting engine oil pan is removed for any reason it should be thoroughly cleaned before it is reinstalled. The oil pump screen should also be cleaned while the oil pan is off the engine.

FUELS

As a source of power the diesel engine has two outstanding advantages over the gasoline engine. The first is its lower rate of fuel consumption — and second its ability to use less expensive fuels. In selecting a fuel, it should be pointed out that distillates are especially desirable because, in refining, they are heated to a vaporous state and condensed in another container; thus all the sediment and residue remain in the still. Always buy the **lowest price distillate fuel giving satisfactory operation.**

In the United States and Canada, there are two general classes of fuel available for diesel engines. The American Society for Testing Materials (ASTM) has established these classes in their specifications. One class is that marketed as fuel oil (domestic furnace oil); the other is that marketed as diesel fuel oil. No. 2 fuel oil and No. 2D diesel fuel oil are recommended for use in Caterpillar Diesel Engines. More expensive "premium" fuels such as No. 1 fuel oil and No. 1D diesel fuel oil are not necessary or recommended for normal operating conditions.

There is considerable variation in the composition of fuels distributed under the No. 2 grade classifications. For desirable engine service, it is most important to give special attention to pour point, cloud point, filterability, sulphur content and cetane number of the fuel.

Pour Point: The pour point of the fuel has no effect on engine performance, so long as the fuel is fluid enough to flow from the diesel fuel tank to the engine fuel transfer pump. The pour point of the fuel should be at least 10° F. below the lowest atmospheric temperature at which the engine must start and operate. This will generally provide a fuel that will flow readily from the fuel tank to the engine fuel transfer pump. In subzero (—18° C.) weather it may be necessary to use No. 1 fuel oil or No. 1D diesel fuel oil to obtain unusually low pour point fuels.

Cloud Point: Cloud point is a low temperature property frequently not reported in fuel characteristics. It is the temperature at which wax crystals become visible, and it is generally above the pour point of the fuel. The cloud point should be below the lowest atmospheric temperature at which the engine will be operated so the filter will not be plugged with the wax formation.

Filterability: A good clean fuel should contain no more than .1% sediment and water. Dirty fuels lead to early filter plugging and in addition, with some fuels, fuel stability and fuel compatibility can result in the formation of gums and resins which will also reduce filter life.

Sulphur Content: As the sulphur content of the fuel increases, the oil change periods should be reduced as indicated in the topic, DIESEL ENGINE CRANKCASE LUBRICATING OIL CHANGE PERIODS.

Cetane Number: This is an indication of a fuel's ignition quality and should never be less than 35 for Caterpillar Engines. A higher cetane number is required at higher altitudes and for easier starting at low temperatures.

There is no world-wide standardization of diesel fuels and the ASTM classifications are not used in many export territories. Therefore, for best results, consult your Caterpillar dealer because he is familiar with fuels that are marketed in his particular area. He will be glad to advise you.

CARE OF THE FUEL SUPPLY

Keep the Fuel Clean: Too much emphasis cannot be placed on the importance of using only clean diesel fuel. It is important to buy clean fuel, and keep it clean. The best fuel can be rendered unsatisfactory by inadequate storage facilities or careless handling. The clearance between the fuel injection pump plunger and the barrel is very small, actually less than .0001 inch (0.00254 mm.), which makes it evident that the invisible particles of dirt which might pass through the filters can damage the finely finished parts.

Effort should be constantly expended to prevent contamination of the fuel. Important steps are to use clean containers and funnels and to reduce the number of times the fuel must be handled. When the fuel can be delivered by the distributor to storage tanks and then pumped from the storage tank to the diesel fuel tank, the handling is reduced to a minimum.

Since natural settling is an effective method of cleaning diesel fuel, the fuel should be allowed to stand at least 24 hours in the storage tank after it has been filled before fuel is transferred to the diesel fuel tank. Be sure to drain all water and sediment that has settled to the bottom of the tank before the tank is refilled. Occasionally, drain all of the fuel and clean the tank thoroughly.

CARE OF THE DIESEL FUEL TANK

Fill the diesel fuel tank at the end of the day, because the incoming fuel will drive out the moisture-laden air and prevent condensation. Every 125 service hours before starting the engine, open the drain cock under the diesel fuel tank and drain off any sediment or water which may have accumulated.

DIESEL FUEL TANK DRAIN

FUEL SYSTEM

The fuel flows from the diesel fuel tank through the fuel line, and the primary fuel filter, if the engine is so equipped, to the fuel transfer pump. The fuel transfer pump supplies fuel under pressure to the fuel filter housing, the filter removes the dirt and other foreign particles. From here the fuel is supplied to the fuel pump manifold for the individual fuel injection pumps. The fuel injection pumps meter and force the fuel through the fuel injection lines and the fuel injection valves in the cylinder head, into the precombustion chambers where it is ignited and passed into the main combustion chamber or cylinder.

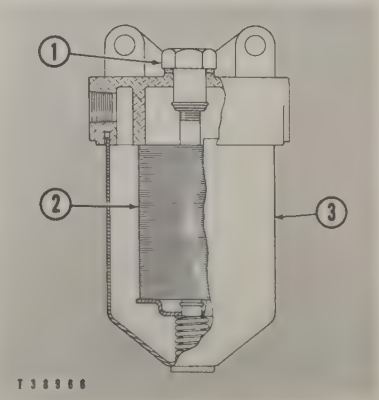
The primary fuel filter in the fuel system is for the purpose of straining out foreign material from the fuel before it enters the fuel transfer pump.

As either the metallic filter element in the primary filter or the resin impregnated cellulose material type fuel filter element in the final fuel filter housing gradually becomes clogged with foreign material, the position of the fuel gauge indicator will work back from the original position in the NORMAL (white) range, to the CAUTION (green) range and later into the OUT (red) range. When the indicator shows in the OUT (red) range, the primary filter element should be removed and washed. If the indicator still shows in the OUT (red) range, the resin impregnated cellulose material type fuel filter element should be replaced.

Primary Fuel Filter

Every 50 service hours remove and clean the filter element.

To remove the filter element **(2)**, stop the engine and shut off the diesel fuel tank valve. Loosen the nut **(1)** on the filter cover and lower the filter case **(3)**. Remove the element and wash in clean kerosene or diesel fuel. Reinstall the element.

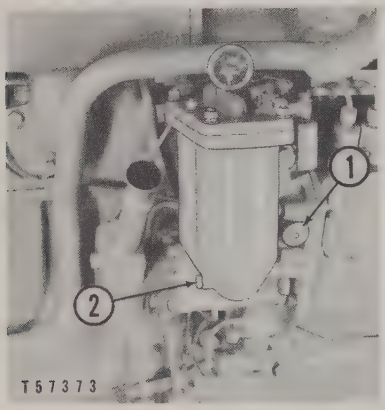


PRIMARY FUEL FILTER

1–Nut. 2–Filter element. 3–Filter case.

Final Fuel Filter

Draining Fuel Filter Housing: Every 50 service hours, or even as often as daily during extremely low temperatures, drain the filter housing of sediment and water which settles to the bottom of the compartment. Close the diesel fuel valve at the fuel tank, remove the filter housing drain plug **(2)** and open the vent valve **(1)** in the housing. Replace the drain plug and prime the system. See the topic, PRIMING THE FUEL SYSTEM.



DRAINING FUEL FILTER HOUSING

1–Vent valve. 2–Drain plug.

Fuel Filter Elements: The fuel filter elements are of the resin impregnated cellulose material type. When the pleated elements have collected enough contamination to interfere with engine performance, they must be replaced with new elements. These elements will continue to collect particles until fuel will no longer flow through them at a rate to maintain maximum engine performance. They will not discharge their burden into the clean fuel; this is prevented by the fine grade filter media around the perforated metal core.

The resin impregnated cellulose material type filter element collects and holds contaminants and cannot be washed or otherwise restored.

Removing Used Filter Elements: To remove the used filter elements, proceed as follows:

1. Close the diesel fuel line valve.
2. Remove the filter housing drain plug.
3. Open the vent in the filter housing.
4. Thoroughly clean the top of the cover and around the edges of the gasket joint between the filter housing and cover to prevent dirt dropping into the filter housing when it is removed.
5. Remove the filter housing from the cover.
6. Lift the filter elements out of the housing.

The rods and rod springs may be lifted out of the housing to permit the inside of the housing to be thoroughly cleaned if so desired.

Installing Filter Elements in Housing: To install the elements in the housing proceed as follows:

1. Replace the rods **(2)** and springs in the housing if they have been removed.

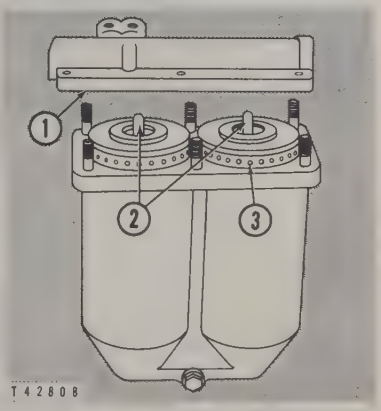
   While inserting the rod in the drilled hole in the bottom of the filter housing, hold the rod and spring with one hand to be sure the spring is held in position on the lower end of the rod.

2. Place the filter elements **(3)** over the rods.

3. Place a new gasket on the filter housing.

4. Install the housing onto the cover **(1)**, making certain that the rods enter the holes for the rods in the cover.

5. Prime the system as outlined in the topic, PRIMING THE FUEL SYSTEM.



INSTALLING FUEL FILTER ELEMENTS

1–Cover. 2–Rods. 3–Filter elements.

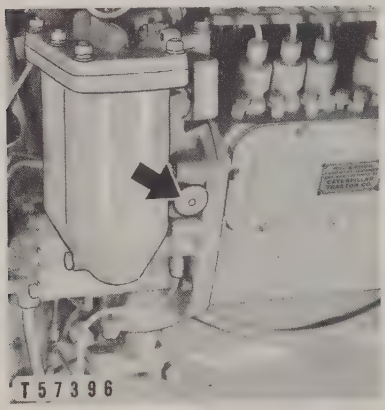
Keep a New Filter Element on Hand: An extra filter element should be kept on hand for replacement. Always keep the element wrapped and in its original carton to insure against dust and dirt accumulation which will shorten the life of the element if it gets on the outside, or may cause damage to the fuel injection equipment if it gets on the inside.

PRIMING THE FUEL SYSTEM

Any time the fuel flow is broken and air is allowed to get into the fuel system, the fuel system must be primed. If the air is left in the lines, the fuel system may become air bound, resulting in inability to start the diesel engine or the misfiring of one or more cylinders.

Priming the Fuel System - Direct Electric or Air Starting Motor: Priming the fuel system will allow the fuel transfer pump to force air and fuel through the fuel filters and the fuel injection pump vents if the engine is level. Prime the system as follows:

1. Check to see that the diesel fuel tank valve is open.
2. Move the governor control lever to the stop position, so the fuel injection pumps are closed.
3. Open the fuel filter vent valve.



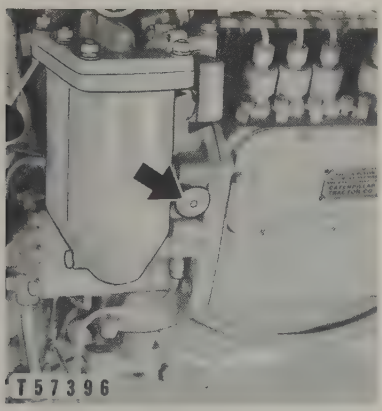
FUEL FILTER VENT VALVE

FUEL PRIMING PUMP
1–Knurled top.

4. Loosen the knurled top **(1)** of the fuel priming pump and operate the pump plunger up and down until fuel flows from the fuel filter vent valve. Continue to operate the fuel priming pump until the flow of fuel from the vent valve becomes continuous and contains no air bubbles.
5. Open and close the vent valve several times to be sure that all the air is bled from the system. Close the vent valve.
6. Tighten the knurled top of the fuel priming pump to its original position.

Priming the Fuel System - Gasoline Starting Engine: Priming the fuel system will allow the fuel transfer pump to force air and fuel through the fuel filters and the fuel injection pump vents if the engine is level. Prime the system as follows:

1. Check to see that the diesel fuel tank valve is open.
2. Move the governor control lever to the stop position, so the fuel injection pumps are closed.



FUEL FILTER VENT VALVE

3. Move the compression release lever to the START position.
4. Start the starting engine, engage the starter pinion and clutch. Allow the starting engine to crank the diesel engine at starting engine low idle speed.
5. Open the fuel filter vent valve. When the flow of the fuel from the fuel vent drain tube is continuous and contains no air bubbles, close the vent valves.
6. Open and close the vent valve several times to be sure all air is bled from the system.

FUEL INJECTION EQUIPMENT

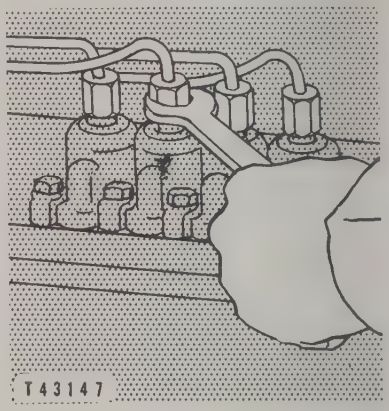
When improper fuel injection is affecting the diesel engine operation, a systematic check should be made to determine the cause. The most likely cause is dirt or water in the fuel. Drain the sediment from the diesel fuel tank and drain the fuel filter housing. Check the fuel pressure gauge as mentioned in the topic, FUEL SYSTEM. Replace the filter elements and/or clean the primary fuel filter if necessary. Then prime the fuel system until clean fuel passes through the fuel vent drain tube. If the fuel system is air bound, priming the system will overcome the difficulty.

When the engine is running irregularly, and smoking, a fuel injection valve may not be spraying the fuel properly.

As the clearance between the plunger and the barrel of a fuel injection pump increases, due to wear, fuel leakage occurs. When the leakage increases to the point where insufficient fuel is injected into the cylinder, a loss of power is noticeable. With the loss of power hard starting is also encountered.

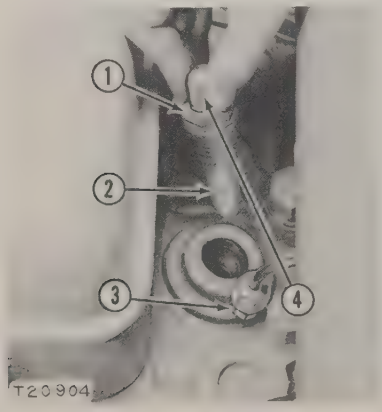
Fuel Injection Valves

Testing Fuel Injection Valves: Whenever an engine performs in such a manner that a fuel injection valve is suspected of causing trouble, test all fuel injection valves. To test the injection valves, loosen the fuel injection line nuts at the fuel injection pumps, one at a time, while the engine is running. When a nut is loosened and the exhaust smoking is completely or partially eliminated and the irregularity in running is not affected, this identifies the defective valve and a new one should be installed in that cylinder. These valves can be tested by your Caterpillar dealer.



LOOSEN FUEL INJECTION LINE NUT TO TEST VALVE

Removing Fuel Injection Valves: Before removing a valve clean the dirt from around the valve and connections. If the engine is equipped with glow plug starting aids the glow plug should first be removed before removing and replacing a fuel injection valve to eliminate the possibility of damaging the glow plug.



REMOVING FUEL INJECTION VALVE

1–Retainer nut. 2–Fuel injection valve nozzle assembly. 3–Plug. 4–Cover.

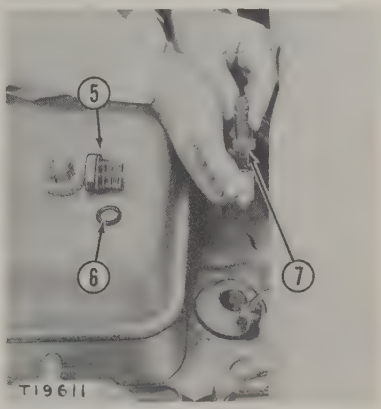
Disconnect the fuel injection line from the injection valve and pump. Install the plug **(3)** and cover **(4)**. Remove the valve retainer nut **(1)** and lift out the nozzle assembly **(2)** and body as a unit.

Installing Fuel Injection Valves: Before installation of a fuel injection valve, be sure the wrench is clean. Put the dust cover on the valve body as soon as possible to prevent dirt entering the fuel passage. Install the fuel injection valve in the following manner:

1. Screw the valve body **(7)** into the fuel injection valve nozzle assembly only finger tight. The threads of the body and nozzle assembly are made to fit loosely. The clearance between the threads provides a passage for fuel to enter the nozzle assembly from the body.
2. Insert the nozzle assembly and valve body as a unit into the precombustion chamber opening. Turning the body in a clockwise direction and at the same time pressing down will assure alignment of the serrations.
3. Install a new large seal **(5)** on the retainer nut. A light coating of lubricant on the seal will permit it to seat properly.

INSTALLING FUEL INJECTION VALVE

5–Large seal. 6–Small seal. 7–Injection valve body.



4. Tighten the retainer nut to prevent leaks between the nozzle assembly and nozzle assembly seats. A torque of 100 to 110 pounds feet is adequate to tighten the retainer nut.
5. Place a new small seal **(6)** over the threads on the top of the valve body and on the retainer nut.
6. Connect the fuel injection line and tighten the nuts.

Fuel Injection Pumps

Testing Fuel Injection Pumps: It is not usual for one pump on an engine to require replacement, usually all of the pumps are worn. Worn fuel injection pumps will result in loss of power and hard starting. When loss

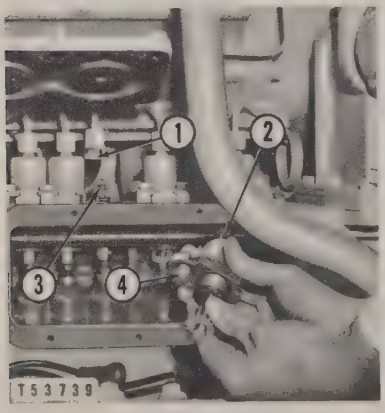
of power and hard starting is accompanied with a clear exhaust, good compression and no blow-by gases from the crankcase breather it indicates worn injection pumps. These pumps can be checked by your Caterpillar dealer.

Removing Fuel Injection Pumps: Every precaution should be taken to prevent dirt from getting into the fuel injection pumps or housing. Clean the top of the housing and around the inspection plate before removing the plate. When fuel injection pumps are removed, the pump plungers must not be taken from the barrels because dust or dirt will scratch these finely finished parts.

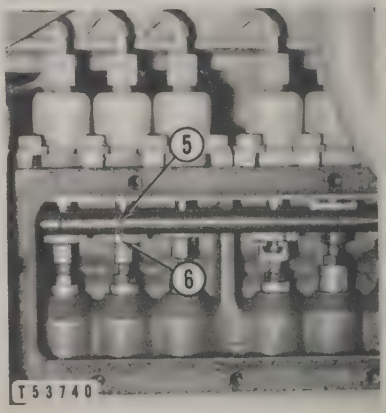
After cleaning the top of the housing, and around the inspection plate, remove the fuel injection lines from the pumps and immediately cap and plug the opening with covers **(2)** and plugs **(1)** provided in the tool equipment. Remove the inspection plate.

Remove the capscrews and clamps holding the fuel injection pump to the housing and lift the pump straight up only enough to clear the dowel pins. Then insert a finger through the inspection hole, hold the plunger from dropping out and shift the pump to one side so the end of the pump plunger will free itself from the slot in the lifter. Place the ferrule cap seal **(3)** and stopper **(4)** furnished in the tool equipment over the fuel outlet of the fuel housing and in the inlet of the pump to keep out dirt.

Should the plunger accidentally be removed from the pump barrel, take every precaution to avoid nicking or scratching it since the slightest rough spot will cause undue wear in the barrel and shorten the life of



REMOVING FUEL INJECTION PUMP
1–Fuel line plug. 2–Cover. 3–Ferrule cap seal. 4–Stopper.



INSTALLING FUEL INJECTION PUMP
5–Mark on rack. 6–Marked tooth on gear.

the pump. The plunger should be rinsed in clean fuel before putting it back in the barrel. Be sure the plunger is replaced in the barrel from which it was withdrawn. **Each fuel injection pump assembly (plunger and barrel) is machined as a unit and finished to such exact limits that it must be used, removed and replaced as a unit.**

Installing Fuel Injection Pumps: Lower the pump and plunger into the housing, taking care that the pump plunger does not slide out of the pump. Line up the marked tooth **(6)** of the injection pump plunger gear with mark **(5)** on the rack as the plunger is lowered into place. Slide the end of the plunger into the slot in the lifter. Remove the ferrule cap seal and plug from the fuel passage and lower the pump onto the dowel pins. Fasten the pump in place.

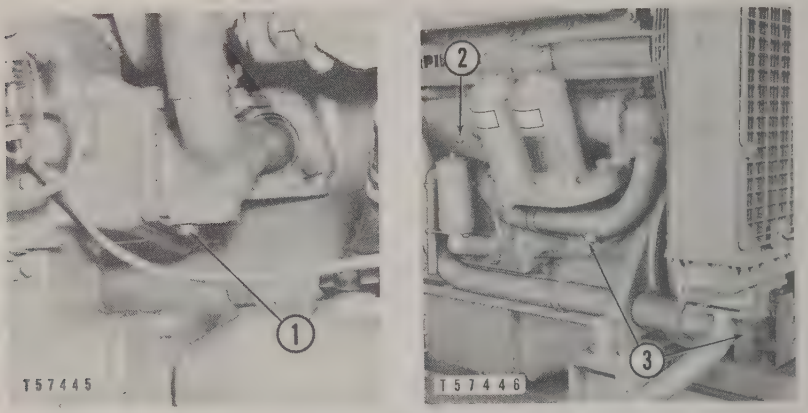
COOLING SYSTEM

Coolants: Water used in the cooling system should be soft, or as free as possible from scale forming minerals. If it is impossible to obtain soft water it is advisable to treat the available water with Caterpillar Rust Inhibitor. The use of this rust inhibitor in the cooling system will prevent the formation of rust. It will also retard, and in some cases completely eliminate mineral deposits within the engine. Most commercial anti-freeze solutions contain rust inhibitors, therefore, it is not necessary to use rust inhibitors with those anti-freeze solutions which do contain inhibitors. Your Caterpillar dealer stocks Caterpillar Rust Inhibitor in convenient one quart cans. Directions for its use are printed on each can.

When the temperature is below freezing sufficient anti-freeze should be used in the fresh water cooling system to prevent freezing. Various anti-freeze mixtures such as ethylene glycol (Prestone, G.M., Permaguard, Zerex, etc.), denatured ethyl alcohol, methanol (synthetic wood or methyl alcohol) and glycerine are all suitable for use. Alchohol can be used successfully but, because it readily evaporates at the normal operating temperature of the diesel engine the solution should be tested frequently —even daily—and kept up to correct strength. This loss by evaporation is objectionable **but the temperature regulator should not be removed.** Doing so might make the solution run cooler and save the alcohol, but is not desirable for good performance. It is essential, therefore, that the coolant be tested frequently to assure adequate protection.

Filling: Fill the starting and diesel engine cooling system by pouring the coolant into the radiator filler opening.

Draining: Every 1000 service hours drain and refill the cooling system. The cooling system is drained by removing the radiator cap and the drain plugs located in the starting engine water elbow **(1)**, the cylinder block drain **(2)** located on the left side of the engine and the water line drains **(3)**. This should be done at the end of the day's run when all the material is in suspension and will drain with the coolant.



COOLING SYSTEM DRAIN PLUGS
1–Starting engine water elbow drain plug. 2–Cylinder block drain plug. 3–Water line drain plugs.

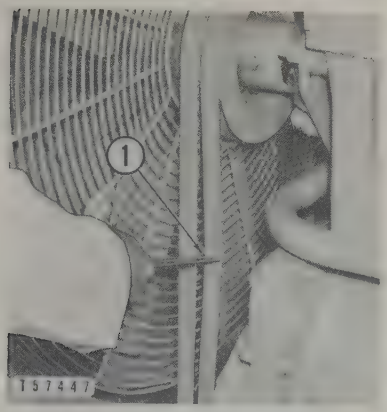
Cleaning the Cooling System: An occasional washing of the cooling system may be necessary to remove the dirt and sediment which accumulates. The frequency of washing will depend on the amount of foreign material present in the water used in the system.

To wash the system, run the engine until the liquid in the cooling system is at operating temperature, and the loose foreign material is stirred up. Then stop the engine, and drain as quickly as possible before the sediment has time to settle. Close the drain and pour in kerosene equal to about one-tenth the capacity of the cooling system and fill the remainder with a solution of one-half pound (226.8 grams) of washing soda to each gallon (3.8 liters or .8 Imp. Gal.) of water. Run the engine for about one-half hour, and again drain and flush the system with clean water. Commercially available cooling system cleaners may be used.

FAN BELT ADJUSTMENT

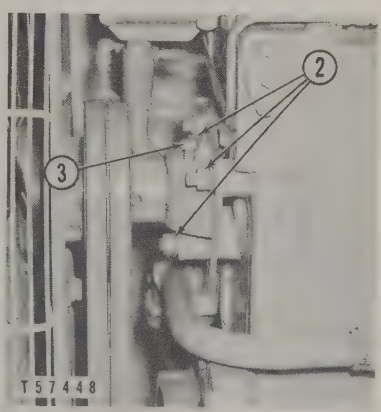
The fan belts should be checked every 250 service hours for proper adjustment. If the fan belts are operated too loose, they will slap against the pulleys, causing unnecessary wear to the belts and possibly slipping to the extent that the engine will overheat. If the belts are too tight, unnecessary stresses are placed upon the fan bearings and belts, which might shorten the life of both. Correct adjustment exists when the belts can be pushed inward 3/4 to 1 inch (1.91 to 2.54 cm.) with approximately 25 pounds pressure exerted midway between the pulleys as shown at **(1)**.

When a belt, or belts, need replacing, a matched set which is available from your Caterpillar dealer should be used. Always install a matched set — never only one.



CHECKING FAN BELT TENSION

1–Correct adjustment allows ¾ to 1 inch (1.91 to 2.54 cm.) slack at this point.



FAN BELT ADJUSTMENT

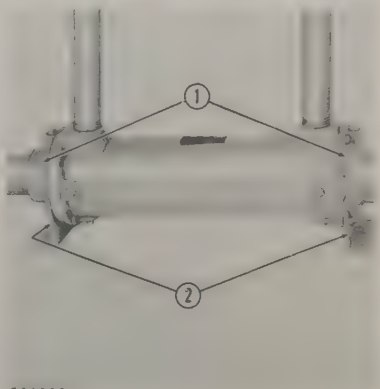
2–Retaining nuts.
3–Adjusting screw.

Adjusting Belts: Loosen the three retaining nuts **(2)** which hold the fan hub bracket to the support bracket. Turn the adjusting screw **(3)** until the belts can be pushed inward ¾ to 1 inch (1.91 to 2.54 cm.) with approximately 25 pounds pressure exerted midway between the pulleys as shown at **(1)**. Recheck the adjustment after tightening the retaining nuts.

HEAT EXCHANGER

The heat exchanger should be cleaned when the water temperature is continuously 195° F. to 205° F. or more during operation.

Drain the exchanger of raw water by removing the drain plugs **(2)**. Remove the end bonnets **(1)** from each end of the exchanger. A rod not larger than 9/32 inch (7.11 mm) can be used to push through the tubes of the core to remove accumulations. Reinstall the end bonnets. When the engine is started, any accumulations which were loosened in the tubes will be flushed out of the core.



CLEANING HEAT EXCHANGER

1–End bonnets. 2–Raw water drain plugs.

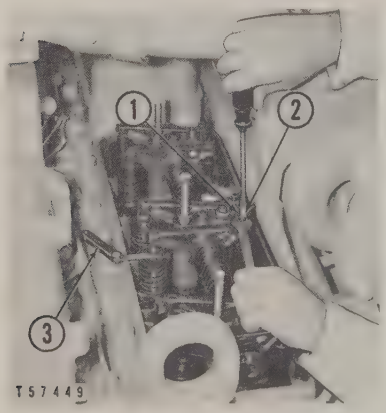
VALVE CLEARANCE ADJUSTMENT

The initial valve clearance adjustment should be made after the first 250 service hours of operation. Thereafter, the clearance should be checked and adjusted if necessary after every 500 service hour operating interval.

The valve clearance adjustment should be made while the engine is hot, either while the engine is running or before it has been stopped twenty minutes after having run long enough to thoroughly warm up. If the adjustment is made with the engine stopped and is not completed during this twenty minute interval, start the engine and allow it to warm up. The valve clearance adjustment must be made, or the clearances checked, with the compression release lever in the RUN position.

To Adjust: Loosen the valve adjusting screw locknut **(1)**, turn the adjusting screw **(2)** to allow the thickness gauge **(3)** to pass between the top of the valve stem and the end of the valve rocker at the correct clearance. Set the clearance for the inlet valves at .018 inch (.46 mm.) and for the exhaust valve at .030 inch (.76 mm.). Tighten the adjusting screw locknut and check the adjustment.

If adjustment is made with the engine stopped, turn the engine until the valve closes and the push rod is at its lowest point.



VALVE CLEARANCE ADJUSTMENT

1–Locknut. 2–Adjusting screw. 3–Thickness gauge.

Check Valve Rotators: Check the valve rotators with the engine running, after the valve clearance adjustment check has been made, to see if the valves rotate. The rotating of valves decreases carbon build up and uneven wear, thereby increasing the life of the valves. To check the rotation of the valves, observe the lines on the spring center retainer. If the valves do not turn, the valve rotators should be replaced. See your Caterpillar dealer.

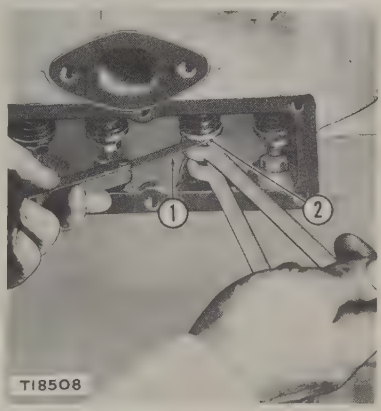
Attachment Instructions

Attachments are available from your Caterpillar dealer. Many of these attachments will add to operator comfort and convenience as well as increase the usefulness of your engine.

STARTING ENGINE VALVE CLEARANCE ADJUSTMENT

The valve clearance adjustment should be checked every 2000 service hours. To check the adjustment remove the carburetor and valve cover. The valve clearance check or adjustment should be made when the engine is hot. To check, crank engine until the valve closes and the valve-lifter is at its lowest position.

To Adjust: Turn the adjusting screw until there is .008 inch (0.2 mm.) clearance at **(2)** between the adjusting screw and the end of the valve stem. Check this clearance with a thickness gauge **(1)**.



STARTING ENGINE VALVE CLEARANCE ADJUSTMENT

1–Thickness gauge. 2–There should be .008 inch (0.2 mm.) clearance at this point.

SPARK PLUG ADJUSTMENT

The spark plugs should be examined every 1000 service hours. The gap should be kept at approximately .030 inch (.76 mm.). Measure this gap with a thickness gauge. To adjust the gap, bend the outer electrode.

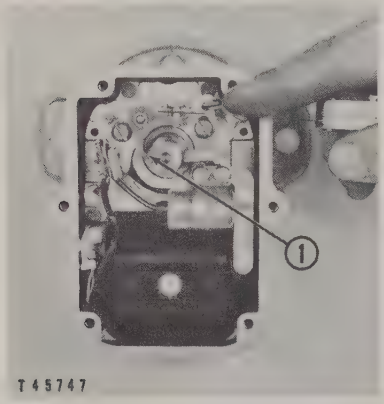
STARTING ENGINE MAGNETO

Wico Magneto

Do Not Lubricate the Magneto at Any Point: The bearings are packed with a ball and roller bearing grease when assembled, and this should be replaced only when the magneto is taken to your Caterpillar dealer for checking or reconditioning.

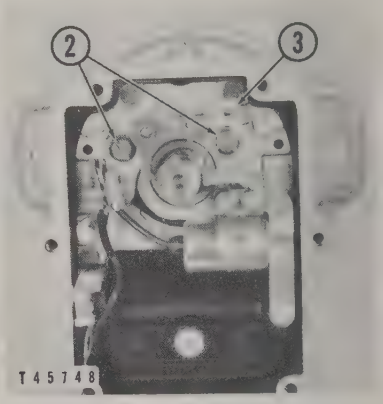
Checking Contact Point Opening: Every 1000 service hours check the contact point opening.

To check, first remove the distributor cap. Care should be taken in removing the cap not to damage the gasket. Clean any carbon dust from inside the cap and any carbon track from the rotor by using a soft cloth dampened with a nonflammable cleaning fluid. Remove the distributor rotor, then turn the engine until the contact point bumper block **(1)** is on one of the highest elevations of the cam. Check the clearance with a thickness gauge between the contact points as illustrated. This clearance should be .015 inch (.38 mm.).



CHECKING CONTACT POINT OPENING

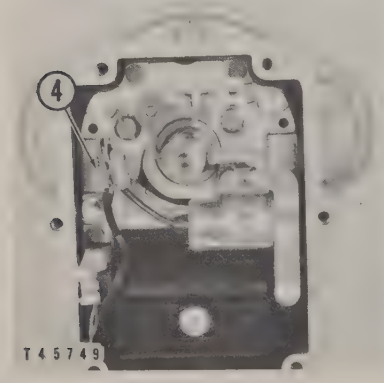
1–Contact point bumper block on one of the highest elevations of the cam.



ADJUSTING CONTACT POINT OPENING

2–Bracket fastening screws.
3–Slot.

Adjusting Contact Point Opening: Loosen the screws **(2)** which hold the adjustable contact point bracket and move the bracket by inserting a screwdriver in the slot **(3)** and turn either clockwise or counterclockwise until the correct point opening is obtained. Then tighten the fastening screws and recheck the adjustment.



REMOVING CONTACT POINTS

4–Spring clamp screw.

To Remove the Contact Points: To remove the contact points, remove the spring clamp screw **(4)** and the two screws **(2)** used in adjusting the contact point opening.

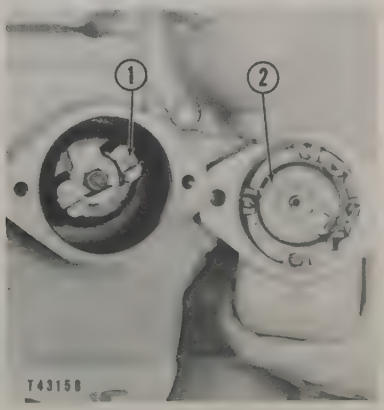
On earlier magnetos, also remove the lock and washer which retain the movable contact point.

Testing: A magneto can be tested when coupled to the engine. Remove the cable from a spark plug (rotate the terminal to facilitate removal), insert a 1/4 inch (6 mm.) bolt or similar metal object into the terminal to contact the wire, and hold the terminal so the end of the bolt is 1/8 inch (3.17 mm.) away from the metal base of the spark plug. Turn the magneto switch ON and crank the engine. If no spark occurs between the bolt and the spark plug base, disconnect the switch wire from the terminal on the magneto and test again. If a spark now occurs with the switch wire removed, the wire from the magneto to the switch has become grounded or the switch requires replacement. If, with the switch wire off, the magneto still does not fire, remove the magneto as instructed in the next paragraph and take it to your Caterpillar dealer for testing.

To Remove the Magneto for Testing: Disconnect the cables from the magneto. One of the cables should be tagged or marked in some convenient manner which will designate the proper position of these cables. Remove the two bolts that hold the magneto to the timing gear cover and lift off the magneto.

To Time the Magneto to the Engine: To time the magneto to the engine, proceed as follows:

1. Locate the "X" mark **(1)** on the starting engine magneto drive.
2. Turn the magneto impulse coupling until the "X" mark **(2)** on the tang is in such a position as to line up with the mark on the magneto drive.
3. Install the magneto with the "X" marks together and tighten the bolts.



TIMING MARKS

1–Mark "X" on magneto drive. 2–Mark "X" on the impulse coupling tang.

To Reinstall Magneto Wires: To reconnect the magneto wires proceed as follows:

1. Place the spark plug wire from number 1 cylinder (the cylinder farthest away from the flywheel) into the number 1 wire receptacle of the magneto cap.
2. Install the other spark plug wire.
3. Reconnect ground wire.

American-Bosch Magneto

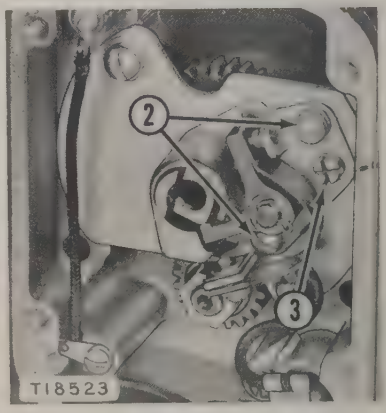
Do Not Lubricate the Magneto at Any Point: The bearings are packed with a ball and roller bearing grease when assembled, and this should be replaced only when the magneto is taken to your Caterpillar dealer for checking or reconditioning.

Checking Contact Point Opening. Every 1000 service hours check the contact point opening.

To check, first remove the distributor plate which is held in place by four screws. Care should be taken in removing the plate not to damage the gasket. Clean any carbon dust from inside the plate by using a soft cloth dampened with a nonflammable cleaning fluid. Remove the distributor rotor, then turn the engine until the contact point bumper block **(1)** is on one of the highest elevations of the cam. Check the clearance with a thickness gauge between the contact points as illustrated. This clearance should be .014 to .018 inch (.36 to .46 mm.).

CHECKING CONTACT POINT OPENING

1–Contact point bumper block on one of the highest elevations of the cam.



ADJUSTING CONTACT POINT OPENING

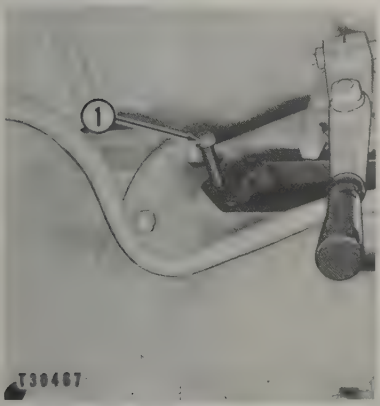
2–Bracket fastening screws.
3–Eccentric slotted screw.

Adjusting Contact Point Opening: Loosen the screws **(2)** which hold the adjustable contact point bracket and move the bracket by inserting a screwdriver in the eccentric slotted head screw **(3)** and turn either clockwise or counterclockwise until the correct point opening is obtained. Then tighten the fastening screws and recheck the adjustment.

Testing: A magneto may be tested when coupled to the engine by turning the switch, ON, removing the cable from a spark plug, and holding the terminal 1/8 inch (3.17 mm.) away from the metal base of the plug while cranking the engine. If no spark passes from the terminal to the metal base, disconnect the magneto switch wire from the magneto where it is connected to the terminal on the top of the magneto housing and test again. If a spark passes from the terminal to the base with the switch wire removed, the wire running from the magneto to the switch has become grounded or the switch requires replacement. If, with the switch wire off, the magneto still does not fire, remove the magneto as instructed in the next paragraph and take it to your Caterpillar dealer for testing.

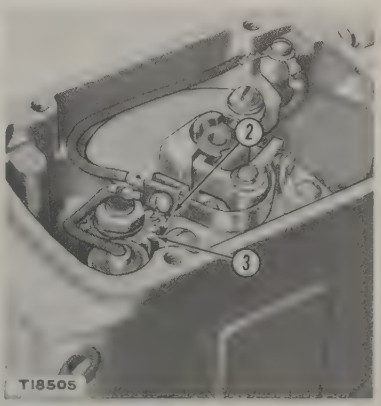
To Remove the Magneto for Testing: Disconnect the cables from the magneto. One of the cables should be tagged or marked in some convenient manner which will designate the proper position of these cables. Remove the two bolts that hold the magneto to the timing gear cover and lift off the magneto. Do not remove the magneto mounting trunnion when lifting the magneto from the engine.

To Time the Magneto to the Engine: Check the adjustment of the contact points. Locate the firing point of No. 1 cylinder by removing the cover from the top of the starting engine clutch housing and the spark plug from No. 1 cylinder. Crank the engine slowly until air is forced from the spark plug opening. This indicates the piston is coming up on the compression stroke. Place a 3/8 inch x 2 inch bolt **(1)** in the hole in the



LOCATING CORRECT POSITION OF FLYWHEEL FOR TIMING MAGNETO TO ENGINE

1–Bolt.

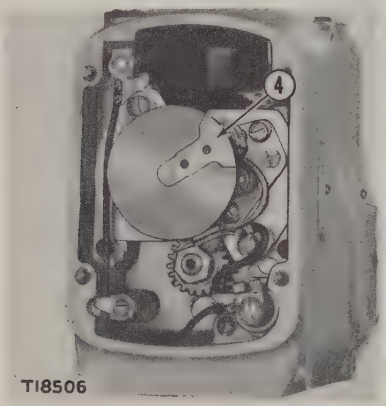


TIMING MARKS ON MAGNETO

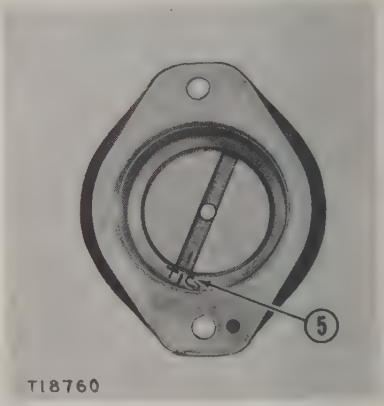
2–Mark "A" on the distributor gear.
3–Magneto rotor shaft gear.

flywheel housing. Continue to turn the crankshaft slowly until the bolt drops in the hole in the flywheel. Remove the bolt and replace the cover.

Remove the plate at the end of the magneto by taking out the four small fastening screws. Turn the magneto shaft backwards (to prevent the impulse from catching) until the mark "A" on the distributor gear **(2)** line up with the red line on the magneto rotor shaft gear **(3)**. At this point if the distributor rotor is installed the distributor rotor contact **(4)** should be in the position shown. When the distributor plate is installed the No. 1 cylinder spark plug wire conductor in the plate will contact the rotor contact **(4)**.



ROTOR POSITION TO TIME MAGNETO TO ENGINE
4–Rotor contact.



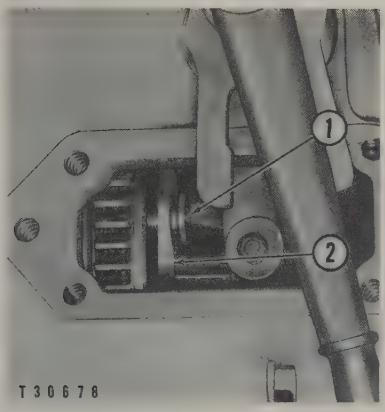
TIMING MARKS ON MAGNETO MOUNTING TRUNNION
5–Mark "TC" in magneto mounting trunnion.

Place the magneto into position, making sure the mark on the impulse lug lines up with the mark "TC" **(5)** in the magneto mounting trunnion, and bolt the magneto into place. Check the location of the rotor before replacing the plate to be sure it has not changed its position and then replace the plate on the magneto.

STARTING ENGINE CLUTCH

To Test the Adjustment: Pull the clutch lever to the engaged position. The lever should go into this position with a distinct snap, and should require a reasonably hard pull. The clutch should be checked every 500 service hours for proper adjustment.

To Adjust: Remove the plate from the top of the clutch compartment. Turn the clutch adjusting collar **(2)** until the lock pin **(1)** is accessible. Pull the lock pin out and turn the collar to the right until the lock pin drops into the next hole.



STARTING ENGINE CLUTCH ADJUSTMENT

1–Lock pin. 2–Adjusting collar.

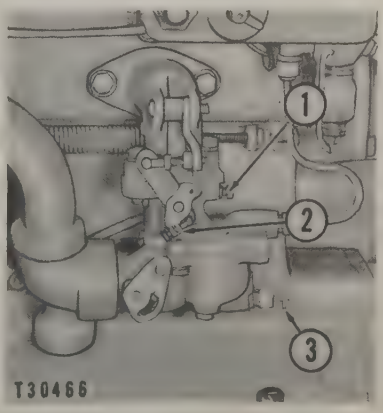
Test the adjustment by engaging the clutch. If one hole gives a slightly loose adjustment and the next gives too tight an adjustment, use the looser adjustment.

STARTING ENGINE FUEL SYSTEM

Keeping the starting engine fuel tank filled will prevent condensation in the tank. Periodically drain any water which may have accumulated in the starting engine fuel tank sediment bowl. Check the carburetor for proper adjustment every 500 service hours.

Occasionally remove the drain filter from the bottom of the starting engine air inlet tube and inspect the filter element. If it is deteriorated, replace it.

Carburetor Adjustment: To obtain an approximate carburetor adjustment, turn the adjusting screws gently against their seats. Then back off the high speed mixture adjusting screw **(3)** one turn from the closed position and the idling speed mixture adjusting screw **(1)** one-half turn from the closed position.

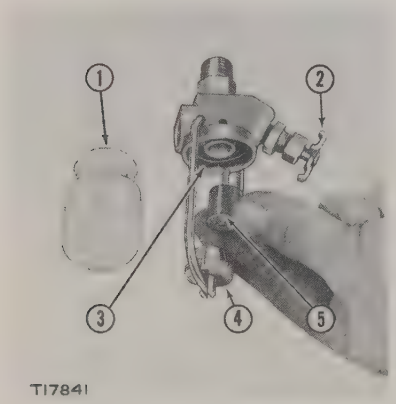


CARBURETOR ADJUSTMENT

1–Idling speed adjusting screw. 2–Idling speed control screw. 3–High speed mixture adjusting screw.

A more accurate adjustment can be made with the engine running at full governed speed by turning the high speed mixture adjusting screw out to make the mixture richer or in to make it leaner. Adjust this screw to a point that will give the greatest amount of power with a clear exhaust. Turn the idling speed mixture adjusting screw until the engine will idle regularly at slow speed without emitting black smoke from the exhaust. Turn this screw out to make the mixture rich or in to make it leaner. Turn the idling speed control screw **(2)** to the left (out) to decrease idling speed or to the right (in) to increase the speed.

Sediment Bowl Filter: The sediment bowl **(1)** collects water and sediment that may be in the fuel. To remove the collected water and sediment, close the valve **(2)** and remove the bowl by unscrewing the nut **(4)** that clamps it to the body of the valve. Unscrew the edge-type filter element **(5)** and shake it in kerosene or some nonflammable cleaning fluid. When the bowl is replaced see that the gasket **(3)** is clean, is in the correct position and is not broken.



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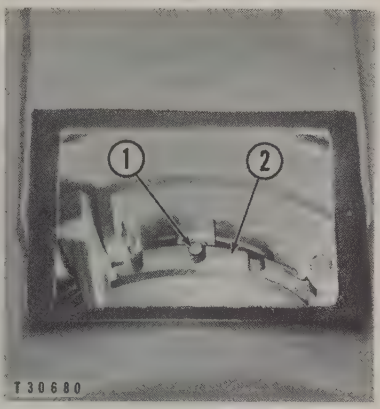
STARTING ENGINE SEDIMENT BOWL FILTER

1–Sediment bowl. 2–Valve. 3–Gasket. 4–Nut. 5–Edge-type filter element.

FLYWHEEL CLUTCH

To Test The Flywheel Clutch Adjustment: Pull the clutch lever to the engaged position. For a desirable adjustment the lever should go into the engaged position with a distinct snap, and should require a reasonably hard pull.

Clutch Adjustment: Remove the inspection cover and turn the adjusting ring **(2)** until the lock pin **(1)** can be reached. Push in the lock pin and tighten the clutch by turning the collar to the right or clockwise until the lock pin drops into the next notch. Test the adjustment by engaging the clutch. If one hole gives too tight an adjustment, and the other gives a slightly loose adjustment, use the looser adjustment. Replace the inspection cover.



ENCLOSED TYPE CLUTCH

1–Adjusting lock pin. 2–Adjusting ring.

Draining the Flywheel Clutch Housing: The clutch plates are designed to operate dry. The drain plug in the bottom of the flywheel housing, should be removed every 50 service hours to drain any lubricant that may have seeped into the compartment from the engine, or clutch bearings. Lubricants for these points should not be allowed to accumulate in the housing.

CHARGING GENERATOR

Never operate a generator with an open circuit between it and the battery.

General Reconditioning: Every 2000 service hours, the generator should be removed, the bearings repacked if necessary and the commutator and brushes checked for glaze or darkening. At the same time the generator should be completely disassembled, washed and have all parts replaced that show evidence of being unsatisfactory for reason of wear. It is suggested that this cleaning and reconditioning be entrusted to your Caterpillar dealer.

Generator Removal: Remove all wires from the generator and tag them so that they may be correctly connected when the generator is reinstalled. Remove the bolts or stud nuts holding the generator in position and lift off the generator.

Generator Installation. Whenever a generator is installed, or reconnected to the generator regulator, it must be polarized **before** starting the engine. Follow the instructions carefully to prevent damage to the generator, generator regulator, or both, due to incorrect polarizing.

1. Place the generator in position and install the bolts or stud nuts.
2. Connect all wires to the generator, regulator and battery.
3. Polarize the generator. See the proper polarizing instructions that follow.

Make sure all connections are clean and tight. See the topics, BATTERY, GENERATOR REGULATOR, CHARGING ALTERNATOR and WIRING.

Polarizing the American-Bosch and 32-Volt Delco Remy Generators:

1. Remove the wire from the regulator terminal marked FIELD.
2. Touch this wire momentarily to the regulator terminal marked BAT.
3. Reconnect the wire to the regulator terminal marked FIELD.

CAUTION

Always disconnect the wire from the regulator terminal marked FIELD. **Never** use a jumper wire between the terminals on the regulator or generator marked FIELD, ARM or BAT.

Polarizing Delco-Remy (6V, 12V and 24V) Generators: Using a jumper wire, momentarily connect it between the terminals of the generator marked ARM and BAT.

Make sure all connections are tight. A poor connection in the charging circuit will cause the generator to build up excessive voltage which may result in burned field or armature windings. A poor connection in the generator field circuit will cause a low voltage.

Generator Regulator

The generator regulator is adjusted at the factory for average operating conditions. The regulator may have to be readjusted to provide the proper charging rate for the particular operating conditions of the machine. In case of failure of either the regulator or generator, both units should be taken to your Caterpillar dealer, where the output of the generator can be checked and the regulator adjusted accordingly.

Charging Rate: The normal function of the generator regulator is to adjust the generator charging rate by sensing the degree of charge in the battery. As the battery becomes fully charged, the charging rate should drop until the ammeter indicates a rate only perceptibly above zero.

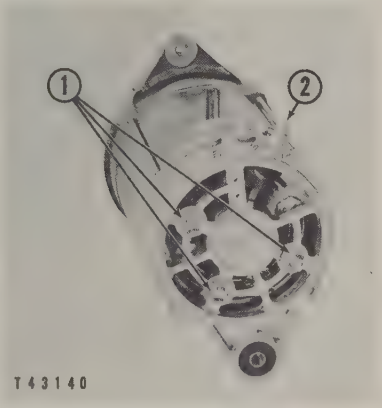
When improper charging of the battery is encountered, the entire electrical system should be carefully checked. Loose or dirty connections, worn or broken wires, or a faulty generator can prevent a good regulator from functioning properly. See the topics, BATTERY, GENERATOR, and WIRING.

Polarity: The tractor electrical system has the negative battery terminal grounded. When connecting the battery, be sure to ground the negative battery terminal. Where the battery grounding is questioned, check the generator regulator to determine the polarity of the system. The battery must be grounded as indicated on the regulator or damage will result

The voltage and polarity of the electrical system are marked either on the cover or on the base of the regulator near a mounting hole. These marks may appear in any of the following forms: "12 VOLTS - NEGATIVE GROUND", "12V - NEG.", or "12V N." Similar marks are used for other voltages and for POSITIVE ground systems.

CHARGING ALTERNATOR

30 and 32 Volt Systems



SELF-RECTIFYING ALTERNATOR

1–Rectifier diodes (six used).
2–"BAT" terminal.

Both the 30 volt and the 32 volt self-rectifying alternators are designed to give long service periods with a minimum amount of maintenance. The grease reservoirs, for each of the two ball bearings on which the rotor is mounted, eliminate the need for frequent bearing lubrication. Six rectifier diodes **(1)** act to change AC power to DC power which appears at the "BAT" terminal **(2)** on the alternator.

Alternator Removal: Remove all wires from the alternator and tag them so that they may be connected correctly when the alternator is reinstalled. Remove the bolts or stud nuts that hold the alternator in position and lift it off the engine.

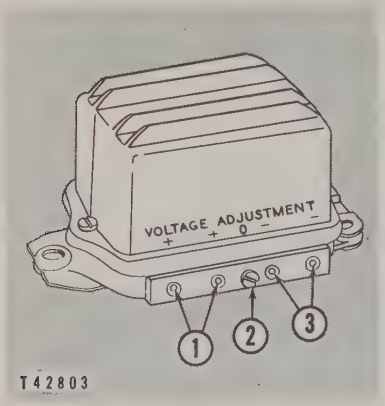
Alternator Installation: Install the alternator on the engine. Correctly connect the wires to the alternator. Do not attempt to polarize the alternator. If an accidental connection is made between the "BAT" and either one of the "F" terminals on the generator, the rectifiers in the alternator will be damaged.

CAUTION

Do not attempt to polarize the alternator. If an accidental connection were made between the "F" and "POS" terminal of the regulator, the rectifiers in the alternator will be damaged.

Alternator Regulator

The transistor type alternator regulator is adjusted at the factory for average operating conditions. The regulator may have to be readjusted to provide the proper charging rate for the particular operating condi-



TRANSISTOR TYPE ALTERNATOR REGULATOR

1–Increase voltage adjustment hole. 2–Screw. 3–Decrease voltage adjustment hole.

tions of the machine. In case of failure of either the regulator or alternator, both units should be taken to your Caterpillar dealer, where the output of the alternator can be checked and the regulator adjusted accordingly.

BATTERY

Every 50 service hours, or more often when continuous operation without the use of the battery is encountered, the following attention should be given to the battery to insure high efficiency and maximum operating life.

Testing: The battery should be tested with a hydrometer and kept to a specific gravity of 1.250 or above. Always test battery for degree of charge before adding water. The specific gravity between the cells should be within .025. A dangerously low point of charge is indicated by a hydrometer reading of 1.150 which will permit the battery to freeze. A specific gravity of 1.250 will permit the battery to withstand temperatures as low as —60° F. without freezing.

Water Addition: The water level should be maintained 3/8 inch (9.5 mm.) above the separators or insulators by addition of distilled water or "approved water" (water free from impurities by analysis). Do not overfill or underfill the cells of the battery as either has a detrimental effect on battery life.

Charging: The charging rate is correct when the battery maintains a minimum of specific gravity of 1.250 and does not require the addition of more than 1 ounce of water per cell per week or 50 service hours.

When there is evidence of either overcharging or undercharging, the cause should be found and corrected as soon as possible to protect the service life of the battery. See the topics, GENERATOR, GENERATOR REGULATOR and WIRING.

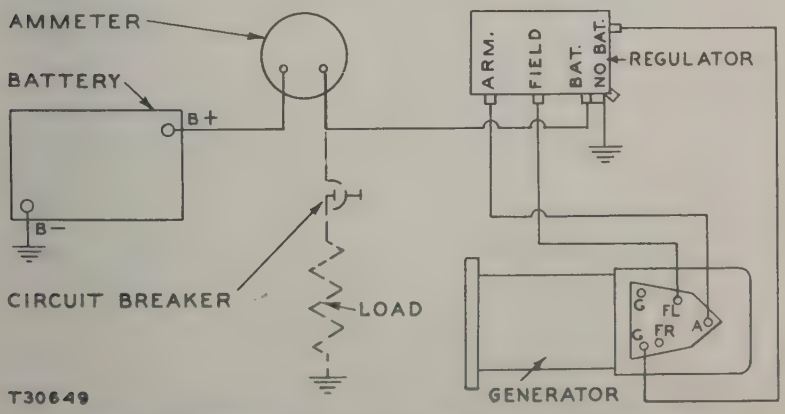
Cleanliness: Keep the top of the battery clean and dry to prevent current losses and keep the terminals clean and tight. To clean corrosion from the battery terminals, scrub them with a weak solution of bicarbonate of soda (baking soda) and water. Dry the battery thoroughly, then coat the terminals with lubricant to prevent corrosion. Keep the battery securely fastened in its compartment at all times.

Installation: When installing a battery in its compartment fasten it securely and be sure to attach the cables to the correct battery terminals. Incorrect grounding of the battery will reverse the polarity of the electrical system and cause damage to the generator regulator. See the topic, GENERATOR REGULATOR.

WIRING

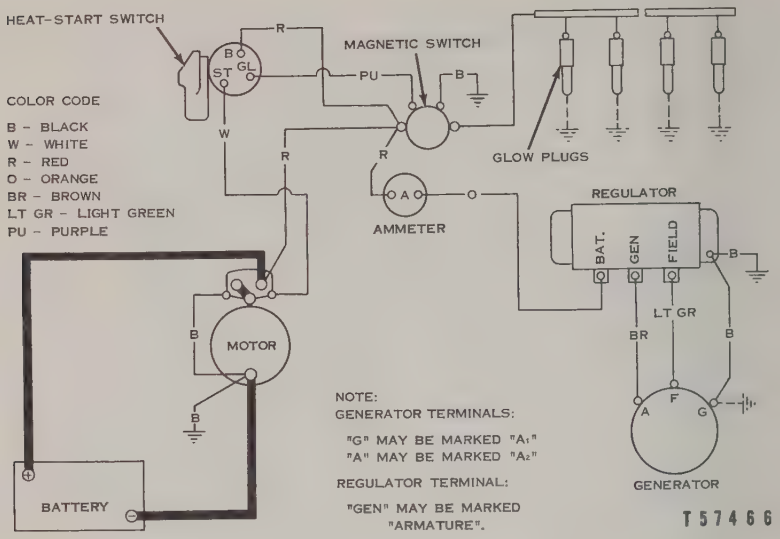
The wiring forms an important part of the electrical system and care should be used to protect it from damage. When the electrical system is being serviced, check the wiring for loose or dirty connections, worn insulation or broken wires. Inspect the battery terminals and cables. Poor connections or wiring can cause trouble or damage in other parts of the electrical system. See the topics, BATTERY, GENERATOR, GENERATOR REGULATOR, ALTERNATOR and ALTERNATOR REGULATOR.

Wiring Diagrams: The diagrams are furnished so that when it becomes necessary to disturb the electrical equipment for purpose of reconditioning or parts replacement, reassembling may be accomplished without difficulty. The battery terminal to be grounded is determined by the generator regulator. See the topic, GENERATOR REGULATOR.

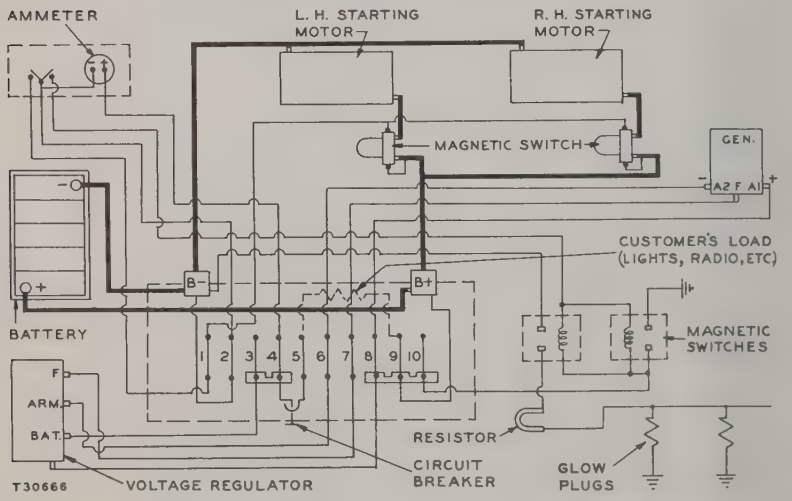


WIRING DIAGRAM FOR 6 VOLT-40 AMP ELECTRICAL SYSTEMS

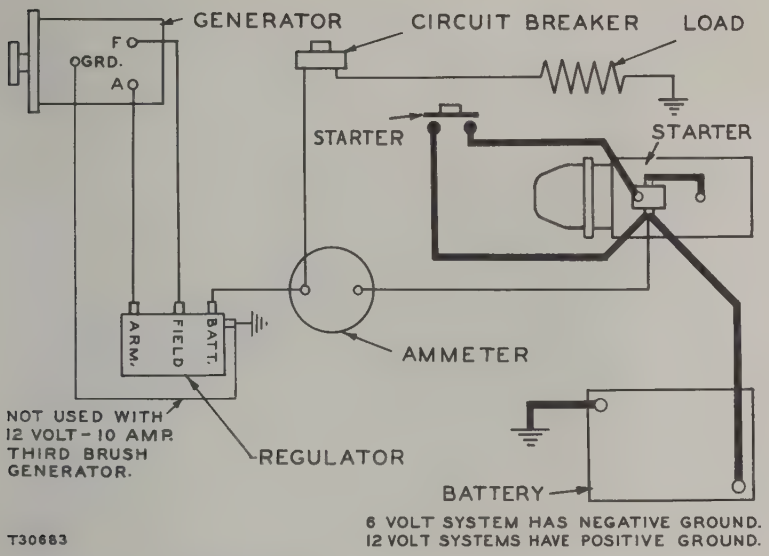
6 volt systems have had either positive or negative battery post grounded. When connecting the battery be sure that the same polarity battery post is grounded that was originally grounded.



WIRING DIAGRAM FOR 32 VOLT ELECTRICAL SYSTEMS
(WITH CHARGING ALTERNATOR)



WIRING DIAGRAM FOR 32 VOLT ELECTRICAL SYSTEMS
HAVING 24 VOLT GLOW PLUGS
(EARLIER ENGINES)



WIRING DIAGRAM FOR 6 VOLT–18 AMP AND 12 VOLT–14 AMP ELECTRICAL SYSTEMS

AIR STARTING MOTOR OILER

The air starting motor oiler automatically meters oil into the air system in the form of a fine fog to lubricate the air motor vanes when the air control valve is opened. An air director tube (venturi tube) located in the air passage of the oiler body **(3)** delivers air pressure above the oil in bowl **(4)**. Oil flows from the bowl through a tube and drilled passage in oiler body **(3)** into the air stream and then to the motor.

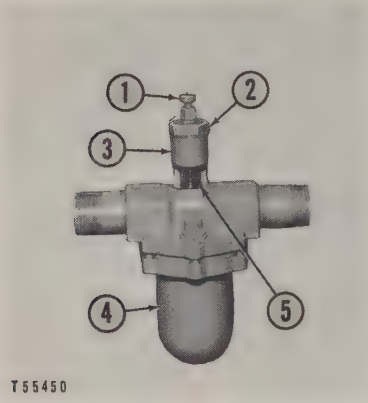
The oiler is designed to operate satisfactorily in a perpendicular position as long as the bowl is kept filled with lubricant. The oiler should be regulated to meter about four drops of oil per minute to the air stream.

Oil drips into the air stream only when air passes through the oil to the air motor.

To regulate the drops of oil from the oiler.

1. Crank the engine with the compression release lever in the start position and the governor control in the shut-off position.
2. Turn valve needle **(1)** counterclockwise to increase or clockwise to decrease the amount of oil.
3. While cranking the engine watch the sight feed glass **(5)** to see the oil dripping.

If the oiler becomes clogged or cannot be adjusted to deliver the proper quantity of oil, remove top plug **(2)** and valve needle **(1)** from the plug. Lift the oil drip gland out of the body and wash it in kerosene or nonflammable cleaning fluid. Be sure the oil passage is open in both the body and drip gland before reinstalling the top plug. If it is sus-



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AIR STARTING MOTOR OILER

1–Valve needle. 2–Top plug. 3–Oiler body. 4–Bowl. 5–Sight feed glass.

◆

pected that dirt or sludge has accumulated in bowl **(4)** remove the bowl and clean it thoroughly in kerosene or nonflammable cleaning fluid and blow out the passages in the body with compressed air.

ELECTRIC STARTER

No periodic service is indicated for the brushes and bearings between general reconditioning periods. The brushes should be inspected after removal of the starter from the engine and removal of the commutator end bearing frame. Replace worn brushes.

Most starting motors have three bearings which should be lubricated with crankcase lubricating oil. When plugs and wicks are provided, remove the plugs and saturate the wicks with oil when the starting motor is reconditioned or removed. When wicks are not provided apply two or three drops of oil to the bearings when the starter motor is disassembled for reconditioning. Overlubrication of the commutator end bearing may cause gum to build up on the commutator and cause poor commutation.

General Reconditioning: Approximately every 4,000 service hours, the starter should be removed so that it may be completely disassembled, washed and have all parts replaced that show evidence of being unsatisfactory for reason of wear. Do not use a degreaser or high temperature cleaning method when cleaning parts of the starter or overrunning clutch. If the overrunning clutch turns roughly when rotated in the overrunning direction or slips in the cranking direction, after the clutch has been washed, it must be replaced with a new clutch. It is suggested that cleaning and reconditioning be entrusted to your Caterpillar dealer.

STARTING AIDS
Glow Plugs

Maintenance: If it is suspected that the glow plugs are not correctly assisting in starting, the system should be checked for defective glow plugs with the engine stopped. An ammeter should be used when making this check to show that each glow plug uses approximately 4, 5 or 7 amperes depending whether the electrical system is 32 volts, 24 volts, or 32 volts reduced to 24 volts by use of a resistor in the glow plug circuit.

An ammeter of sufficient capacity should be connected between the magnetic switch or resistor on the glow plug side, and the lead wire to the glow plug harness. Then move the switch to the HEAT position. A reading on the ammeter should be approximately equal to the number of glow plugs in the system multiplied by 4, 5 or 7 amperes whichever applies. A reading that varies appreciably from this may indicate one or more defective glow plugs.

To locate the defective glow plug or plugs, check each glow plug separately by removing the leads from the glow plugs, one at a time, with the HEAT switch in the ON position. **Reconnect the lead to the glow plug before removing the lead from the next glow plug to be checked.** When a lead is removed from a glow plug with no variation shown in the ammeter, it can be assumed that the glow plug is defective and should be replaced.

GLOW PLUG

CAUTION

The system should be checked frequently for defective glow plugs. On 32 volt electric systems, the HEAT switch should not be held ON over one half minute with a lead disconnected from a glow plug. When a lead is removed from a glow plug and the HEAT switch moved to the ON position, more load is thrown on the remaining plugs in the system, increasing the possibility of burning out additional plugs.

To remove a defective glow plug, disconnect the lead from the glow plug and unscrew the glow plug from the precombustion chamber.

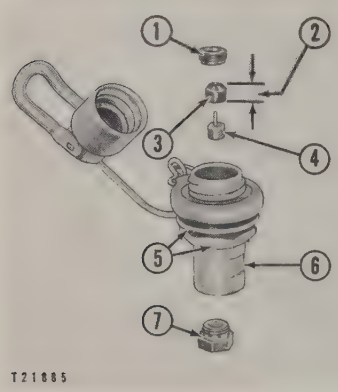
Apply anti-seizure compound to the thread of new glow plug and install the glow plug into the precombustion chamber tightening it to torque of 10 to 12 pounds feet.

The glow plug should first be removed before removing and replacing a fuel injection valve to eliminate the possibility of damaging the glow plug.

Ether Starting Aid

Maintenance: If it is suspected that the ether starting aid is not functioning properly to assist in starting, disassemble the ether discharger **(6)**.

1. Disconnect the tubing from the bottom of the discharger.
2. Remove the screen assembly **(7)** and wash the screen.
3. Remove the nut and washer **(5)** to remove the discharger.
4. Remove the screw **(1)**, rubber washer **(3)** and pin **(4)**.
5. Inspect the pin **(4)** to see that it is sharp. If the pin is not sharp, replace it.



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ETHER DISCHARGER

1–Screw. 2–Free length measurement of 3/8 inch. 3–Rubber washer. 4–Pin. 5–Nut and washer. 6–Ether discharger. 7–Screen assembly.

6. Check the small hole through the pin to see that it is clean.
7. Inspect the rubber washer **(3)**. The rubber washer should have a free length measurement of approximately 3/8 inch as shown at **(2)** and should not be distorted, otherwise replace it.
8. Assemble the discharger and replace it.

PRECAUTIONS

Capsules are filled with ether which is highly flammable. These capsules are pressurized at approximately 250 pounds

pressure to act as an expellant. They are made of steel with welded closures and their bursting pressure is in excess of 6000 pounds per square inch. This type of packaging provides maximum safety in storage, handling and use. The principal precautions to be taken are:

a. Do not heat the capsules.

b. When the discharger is being used for testing, inspecting or demonstrating purposes, and is not installed on an engine, the contents of the capsules should **not** be discharged in confined areas or near an open flame.

WOODWARD UG8 GOVERNOR OPERATION

Starting the Engine

Make the usual checks of lubricant, coolant, fuel supply, cranking capacity (if air starting is used) and disengage the flywheel clutch or remove any load from the engine then perform the following steps:

1. Turn the load limit knob **(3)** indicator between "5" and "7" on the dial.

2. Turn the synchronizer knob **(2)** clockwise or in "fast" direction until the synchronizer indicator **(4)** registers "8" on the dial. (This setting is for an initial start, and experience will determine the correct setting for individual engines). The synchronizer knob controls engine speed the same as a governor control lever or throttle.

3. Crank the engine and allow it to run at about half normal engine speed for five minutes. To adjust the engine speed, turn the synchronizer knob.

4. Turn the load limit knob indicator to "10" which will allow the engine to carry the load as it is applied in step 7. This can be done without overloading of the engine as the load is applied in step 7 because all Caterpillar engines have a separate rack stop to prevent engine overloading.

5. Turn the synchronizer knob clockwise until the engine runs at full rated speed.

6. Three general groups of applications have different speed droop knob settings preliminary to applying the load in step 7 as follows:

A—Single Unit Application:

If the engine is to operate as a single unit, that is, not com-

pounded with other line shafts, the speed droop knob **(1)** indicator should be left at "0" then proceed with step 7.

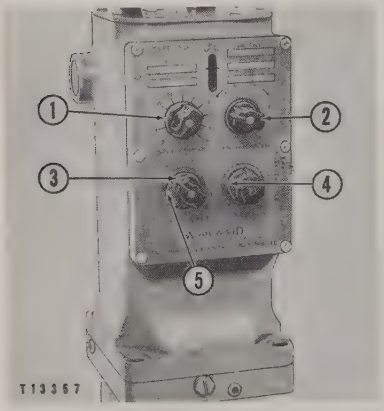
B—Solid Line Shaft Compounding:

If the engine is to be compounded on solid line shafting, set the speed droop knob indicator between "30" and "70", then proceed with step 7.

C—Fluid Coupling and Other Compound Applications:

If the engine is operating an application which is to be compounded with units with similar drives, the speed droop knob indicator should be set at the lowest value which will give a satisfactory load division when the load is applied in step 7. Experience will determine this setting.

7. Apply the load. Readjust synchronizer knob and/or speed droop knob if necessary to secure load division if the unit is paralleled or compounded. The load indicator pointer **(5)** behind the load limit knob indicates the relative position of the fuel rack and indicates relatively the load on the engine.



WOODWARD UG8 GOVERNOR

1–Speed droop knob. 2–Synchronizer knob. 3–Load limit knob. 4–Synchronizer indicator. 5–Load indicator pointer.

The above steps are basically what should be done to start and run the engine when equipped with Woodward UG8 Governor. There are differences in installation and applications, particularly compounded applications, which require adjustments so varied that specific instructions cannot be given in this book. However, the adjustments to the governor after the load is on the engine have the effects as follows:

The engine with the lowest speed droop setting will be the engine which will respond to and carry load increases. The speed droop may have to be adjusted on one or both engines to give speed droops which will result in stable operation and yet provide for load division as the amount of load increases.

To cause an engine to assume more of the continuous load, turn the synchronizer knob clockwise. When the engines are paralleled on solid line shafting, etc., individual engine outputs are adjusted by turning the synchronizer knobs.

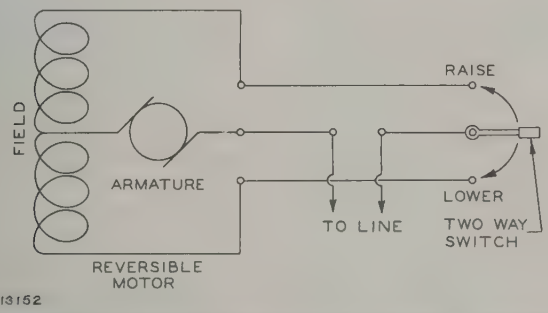
The synchronizer indicator **(4)** merely indicates how many turns the synchronizer knob **(2)** has made.

To Stop the Engine

1. Remove the load and turn the synchronizer knob to allow the engine to idle at about half engine speed for five minutes before stopping. (If the knob is left in this position, step 2 of starting need not be observed at the next start.)
2. Stop the engine by turning the load limit knob to "0". If the temperature is below freezing, or if freezing weather is expected before the engine will be started again, drain the cooling system to protect it with an anti-freeze solution. See the topic, COOOLING SYSTEM.

Synchronizing Motor: A synchronizing motor may be mounted on a special cover for the UG8 governor to provide remote speed control. Its use enables the switchboard operator to match the speed of an engine driven unit with that of other units, or a system, before synchronizing and to change load distribution after synchronizing.

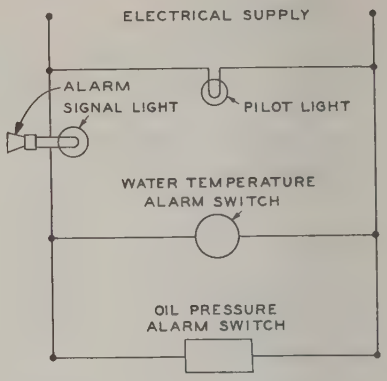
The motor used is of the split field, series wound, reversible type. It can be used on either direct current or alternating current at its specified voltage. It should be wired as shown.



GOVERNOR SYNCHRONIZING MOTOR WIRING DIAGRAM

SAFETY ALARM SWITCHES

The engine may be equipped with a water temperature alarm switch and an oil pressure alarm switch. A signal light, horn or bell or a combination can be placed in the circuit so that the operator will be warned in case the water temperature or oil pressure reach dangerous levels. The operator can then shut-down the engine and correct the difficulty. For further information see your Caterpillar dealer.



TI7569

TYPICAL SAFETY ALARM CIRCUIT

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Water Temperature Alarm Switch (Later Type)

The single pole double throw switch can be wired so that it is either normally open or normally closed. The switch operates due to expansion and contraction of the liquid in the element which is submerged in the engine coolant. The switch operating temperature is stamped on the copper element.

T57478

WATER TEMPERATURE ALARM SWITCH

(Later Type Switch)

◆

The switch is designed to be installed in series with an alarm switch or relay switch having a rating not to exceed the maximum as follows:

1. In circuits of single phase, 115 volts alternating current, connected directly to the alarm, 5 amperes.
2. In circuits of single phase, 230 volts alternating current, connected directly to the relay, 2.5 amperes.
3. In circuits up to 600 volts alternating current, where another switch (relay) is operated, 1 ampere.
4. In circuits of 125 volts, where a direct current relay is employed, .5 ampere.

5. In circuits of 250 volts, where a direct current relay is employed, .25 ampere.

(Earlier Type)

The water temperature alarm switch is located at the front of the engine in the water manifold. The rise in engine water temperature causes the metallic coil to expand, operating a single throw, snap-acting, magnetic switch. This switch is open during cold and normal water temperature ranges. When excessive temperatures are reached the switch is closed thus sounding the alarm.

Oil Pressure Alarm Switch

The oil pressure alarm switch may be mounted on the left side of the engine on a bracket fastened to the timing gear housing. When the engine oil pressure drops to the danger point a diaphragm actuates the contact points thus closing the circuit to sound the alarm.

The switch is designed to be installed in series with alarm or relay switch having a rating not to exceed the maximum as follows:

1—Circuits of 115 volts, alternating current, 15 amperes.

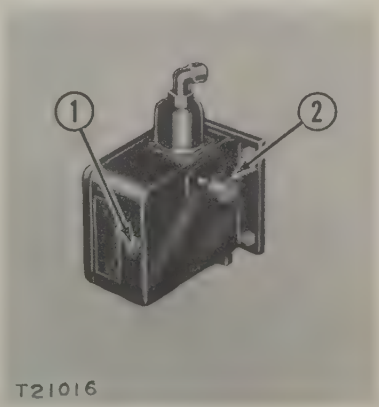
2—Circuits of 230 volts, alternating current, 14 amperes.

3—Circuits of 6 to 32 volts, direct current, 14 amperes.

4—Circuits of 115 volts, direct current, 6.5 amperes.

5—Circuits of 230 volts, direct current, 3.3 amperes.

Oil Pressure Alarm Switch Operation: When the engine is stopped the oil pressure drops closing the switch and causing the alarm to sound. A control knob **(2)** is provided to stop the alarm when the arrow on the knob is turned to the START or OFF position. When the pressure builds up, the knob automatically flips to RUN position. Watch to be sure it does change after each start, as this indicates that alarm contactor is ready to function in case of no oil pressure.



OIL PRESSURE ALARM SWITCH

1–Adjusting screw. 2–Control knob.

Adjustments: This control was originally set at factory, but if it is necessary to change factory setting, proceed as follows:

1—Set manual control knob with arrow pointing to RUN. This places the control in the running position.

2—Decrease all tension on main spring by turning adjusting screw **(1)** to left (counterclockwise).

3—Connect pressure bellows to air pressure line and apply pressure at which contacts are to close, sounding alarm.

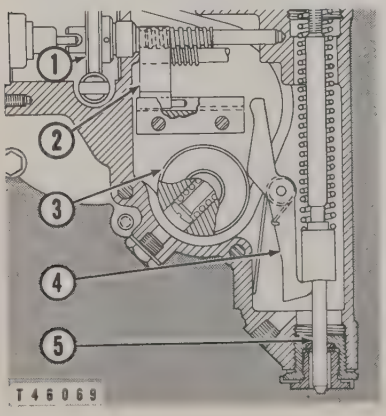
4—Hold pressure on bellows constant and turn adjusting screw to right (clockwise) just to point where contacts open.

SAFETY SHUT-OFF CONTROL

The safety shut-off control is a safety device which is mechanically connected to the diesel engine and will protect the engine from damage by automatically stopping the engine if either the lubricating oil pressure drops and stays below safe limits or if the speed of the engine becomes excessive.

A high water temperature safety shut-off can be connected with the safety shut-off control and will stop the engine if high water temperatures in the cooling system occur.

In the event that the safety shut-off control has stopped the engine because of engine overspeed, low lubricating oil pressure or high water temperatures, the reason for the shutdown must be determined and corrected. After the reason for the shutdown has been corrected the safety shut-off control must be reset before the engine can be started. See the topic, RESETTING THE SAFETY SHUT-OFF CONTROL.



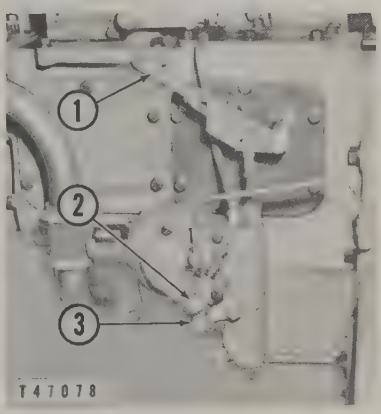
SAFETY SHUT-OFF CONTROL

1–Worm shaft. 2–Slide. 3–Overspeed carrier. 4–Latch. 5–Rod.

◆

Operation: The safety shut-off control is geared to the diesel engine. The overspeed carrier **(3)** and worm shaft **(1)** are always turning whenever the diesel engine crankshaft is rotating. The latch **(4)**, when latched as shown, keeps the spring loaded rod **(5)** from moving the diesel engine fuel injection pump rack into the shut-off position. Slide **(2)** has a rack that can mesh with worm shaft **(1)**. Diesel engine lubricating oil pressure holds the slide away from the worm shaft. If lubricating oil pressure drops and stays below safe operating limits, slide **(2)** meshes with and moves along worm shaft **(1)**. In seven seconds, at engine operating speed, the slide contacts latch **(4)** and releases rod **(5)**. The spring loaded rod when released moves and holds, through mechanical linkage, the fuel injection pump rack in the shut-off position, thus stopping the engine. If the engine overspeeds, a spring controlled weight in overspeed carrier **(3)** moves out by centrifugal force, strikes latch **(4)** and releases rod **(5)** stopping the engine as previously explained.

The safety shut-off control must be reset by pulling up on the shut-off control reset lever until the safety shut-off control latches before the diesel engine fuel injection pump rack can be moved from the shut-off position.



SAFETY SHUT-OFF CONTROL

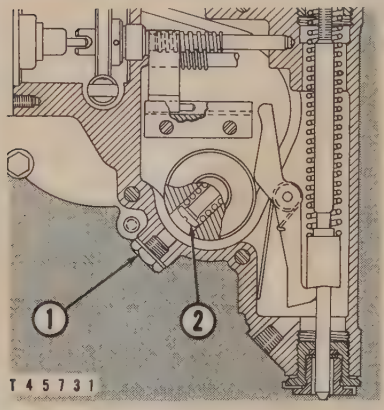
1–Reset lever. 2–Reset button. 3–Manual shut-off button.

The manual shut-off button **(3)**, when pushed will stop the engine. The shut-off button, when pushed simulates an overspeed engine condition by mechanically moving the spring controlled weight far enough out of the overspeed carrier until it strikes the latch and releases the spring loaded rod. The rod, when released moves and holds the fuel injection pump rack in the shut-off position, thus stopping the engine.

Resetting the Safety Shut-off Control: Before the engine can be started after the safety shut-off control has stopped the engine, first push in reset button **(2)**, then pull up on reset lever **(1)** until the safety mechanism latches and the lever will remain in the up position.

CAUTION

After starting, if sufficient oil pressure has not developed, the engine will shut off again after running approximately seven seconds at operating speed. Therefore, check the oil pressure immediately after starting by observing the oil pressure gauge indicator to see that it is in the operating range.



SAFETY SHUT-OFF CONTROL

1–Plug. 2–Weight adjusting screw.

◆

Safety Shut-off Control Adjustment: The only adjustment is for maximum RPM shut-off. Whenever the control has been disassembled or the adjustment disturbed, adjust the maximum RPM shut-off as follows:

1. Remove the plug **(1)** from the bottom of the shut-off control housing.
2. Turn the weight adjusting screw **(2)** in (clockwise) to raise and out (counterclockwise) to lower the maximum RPM shut-off. One complete turn will change the maximum limit 45 to 50 RPM.

NOTE

It may be necessary to rotate the engine flywheel until the adjusting screw can be reached with a screwdriver.

There is no low oil pressure or high water temperature shut-off adjustment.

Water Temperature Shut-off: The water temperature shut-off in itself is a valve connected with the oil pressure portion of the safety shut-off control. If high water temperature in the cooling system occurs, the valve will open and reduce lubricating oil pressure in the safety shut-off control and it is actually the safety shut-off control that functions and stops the engine.

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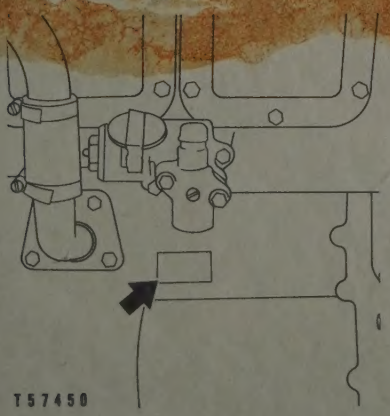
Capacities

Approximate Quantities

	U.S. Measure	Metric Measure	Liters Imperial Measure
Diesel Engine Crankcase Equipped			
with Shallow Oil Pan	40 qt.	38,0	33 qt.
Equipped with Deep Oil Pan	90 qt.	85,5	74.25 qt.
Air Cleaner, Diesel Engine	6½ qt.	6,2	5.4 qt.
Air Cleaner, Starting Engine	½ qt.	,5	.5 qt.
Starting Engine Crankcase	2.5 qt.	2,4	2.1 qt.
Starting Engine Transmission	¾ qt.	,71	.6 qt.
Fuel Tank, Starting Engine	8 qt.	7,57	6.4 qt.
Fuel Tank, Diesel Engine (Base)	143 gal.	543,5	120.2 gal.
Woodward UG8 Governor	1 qt.	,94	.83 qt.
Cooling System			
Engine Only			
(with dry manifold)	25 gal.	23,7	20.8 gal.
(with water cooled manifold)	27 gal.	25,5	22.5 gal.
Radiator Only	10,7 gal.	10,1	8.9 gal.

Location of Serial Number



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